CHAPTER 5 DESIGN ELEMENTS

5.1 GEOMETRIC DESIGN OF SUBDIVISION STREETS

5.1.1 GENERAL

The design of subdivision streets is to be in accordance with the latest standards published by the *American Association of State Highway and Transportation Officials* (AASHTO), DelDOT's *Road Design Manual*, DelDOT's *Bridge Design Manual*, DelDOT's *Design Guidance Memorandums* and DelDOT's *Standards and Regulations for Subdivision Streets and State Highway Access*. Where conflicts exist, DelDOT's *Standards and Regulations for Subdivision Streets and State Highway Access* shall take precedence.

The street layout of a subdivision has the following elements that must be considered by the developer:

- Horizontal and vertical alignment.
- Intersection design.
- Sight distance.
- Typical sections designed to support the traffic volumes anticipated for each road segment.
- Connectivity of both vehicular and pedestrian traffic.
- Traffic calming.

5.1.2 DESIGN CRITERIA FOR SUBDIVISION STREETS

The Design criteria for subdivision streets shall be in accordance with Figure 5-2.

5.1.3 INTERSECTION DESIGN OF SUBDIVISION STREETS

The intersection design of subdivision streets shall be in accordance with the following:

1. The corner radii of internal subdivision streets shall meet the requirements of Figure 5-1. The use of larger radii may be considered if there is a need to accommodate larger vehicles. Any entrance for a new subdivision shall meet the requirements of Section 5.2

Figure 5-1 Intersection Design Radii

Intersection of Subdivision Street		Radii
Type I	Type I	15 feet
Type I	Type II	20 feet
Type II	Type II	25 feet
Type II	Type III	25 feet
Type III	Type III	Set to meet design vehicle

2. Street profiles within 40 feet of the nearest edge of pavement of the intersection may not exceed 5% to provide for sight distance.

3. 90^{o} intersections are preferred. Intersection angles less than 70^{o} are not permitted.

4. The distance required to remove the roadway crown at an intersection is to be established using a maximum relative slope between the profiles of the edge of pavement and centerline of one foot in 150 feet. The roadway crown of the major street is to be maintained.

5. Signing and striping shall be in accordance with MUTCD as adopted by DelDOT.

6. Roundabouts may be used for intersection design within subdivisions. The design shall conform to the standards outlined in the FHWA publication: "Roundabouts: an Informational Guide." At a minimum, the roundabouts shall include a center island, truck apron and splitter islands on all approaches.

Figure 5-2 Design Criteria for Subdivision Streets

Type of Subdivision Street	Design Speed	Sight Distance*	Maximum Grades**	Minimum Horizontal Radii	Minimum K-Value	
					Sag	Crest
Type I (< 500 ADT)	25 mph	150 feet	10%	150 feet	0.26	0.12
Type II (501 – 3000 ADT)	30 mph	200 feet	8%	300 feet	0.37	0.19
Type III (> 3000 ADT)	35 mph	225 feet	7%	500 feet	0.49	0.29
Industrial Streets	35 mph	225 feet	7%	500 feet	0.49	0.29

** Sufficient right-of-way dedicated to the public use shall be provided to maintain the required line-of-sight.*

*** Maximum street grades can be waived on an individual basis subject to DelDOT's engineering judgment with respect to the severity of the topography. Minimum street grades should be 0.5%.*

Notes:

1. *Vertical curves will not be required on streets with an algebraic grade difference of greater than one percent (1%).*
2. *Deviations from these criteria shall only be considered if presented in writing and if it has been proven to the satisfaction of DelDOT that the required criteria cannot be met.*

5.1.4 DEAD END STREETS

5.1.4.1 Permanent Dead End Streets

The use of cul-de-sac and other closed end street situations is to be limited to those situations where the developer's engineer can justify that full street extensions are not possible based on topography, preexisting development or environmental constraints.

Cul-de-sacs must be incorporated in the design of all permanent dead end streets except those eligible to be constructed within a reduced right-of-way. The minimum design criteria for cul-de-sacs are:

1. Design radii shall be in accordance with Figure 5-3.

2. Base material for cul-de-sacs is to extend a minimum of two feet beyond the edge of

paving when an open drainage design is utilized (no curbs).

3. The maximum length for a permanent dead end street is 200 feet measured from the radius return to the start of the cul-de-sac. DelDOT may consider longer lengths if the intent of Sect. 3.5 is met.

Figure 5-3 Design Radii for Cul-de-Sacs

Radius*	Cul-de-sacs	Cul-de-sacs with Center Islands
Right-of-Way	50 feet	60 feet
Outside Edge of Pavement	38 feet	46 feet
Center Island	N/A	24 feet

* *Measured to the face of curb.*

Developers planning streets with reduced right-of-way should select one of the turn-around designs shown in Figure 5-4 in lieu of the standard cul-de-sac. Any alternative design must have prior approval of DelDOT.

5.1.4.2 Temporary Dead End Streets

Temporary dead end streets shall be constructed to the property line of the development in order to provide for future development of adjacent lands. A temporary turn around must be provided when the length of a temporary dead end street exceeds 200 feet. The additional right-of-way needed to accommodate a temporary turn around can be provided through a temporary easement which must be clearly labeled on the site plan. If the street segment is accepted for State maintenance, DelDOT will maintain the temporary dead end street in accordance with Section 3.6.3.

Based on anticipated future development and flow patterns, those streets with more than 500 ADT upon completion of the initial phase development plus the future development must be designed to the appropriate subdivision street level with the corresponding right-of-way width.

If the temporary dead end street shall ultimately provide connectivity to the adjacent property, the following shall apply:

- For all projects with planned connectivity, a note stating "Future Connection to Adjoining Property" shall be prominently displayed on the Record Subdivision Plan.
- For all projects where the connection stub street is constructed as part of the initial or only phase of construction, a sign stating "Street Connection to Future Development" shall be installed by the developer at the end of the stub street prior to the first Certificate of Occupancy being issued. Maintenance of the sign shall be the responsibility of the developer until DelDOT accepts the streets into the State maintenance system.
- For projects where the connection is not constructed until future phases, stub streets shall be constructed to extend to the end of the radii at the intersection with the future street. A sign stating "Future Internal Street and Connection to Future Development" shall be installed by the developer at the end of the stub street. The sign shall be placed immediately after the placement of the base paving course. Maintenance of the sign shall be the responsibility of the developer until DelDOT accepts the streets into the State maintenance system. See Figures 5-5 through 5-7 for stub street sign details.

Figure 5-4 Design Alternatives in lieu of Cul-de-Sacs in Reduced Right-of-Way
(Not to Scale)

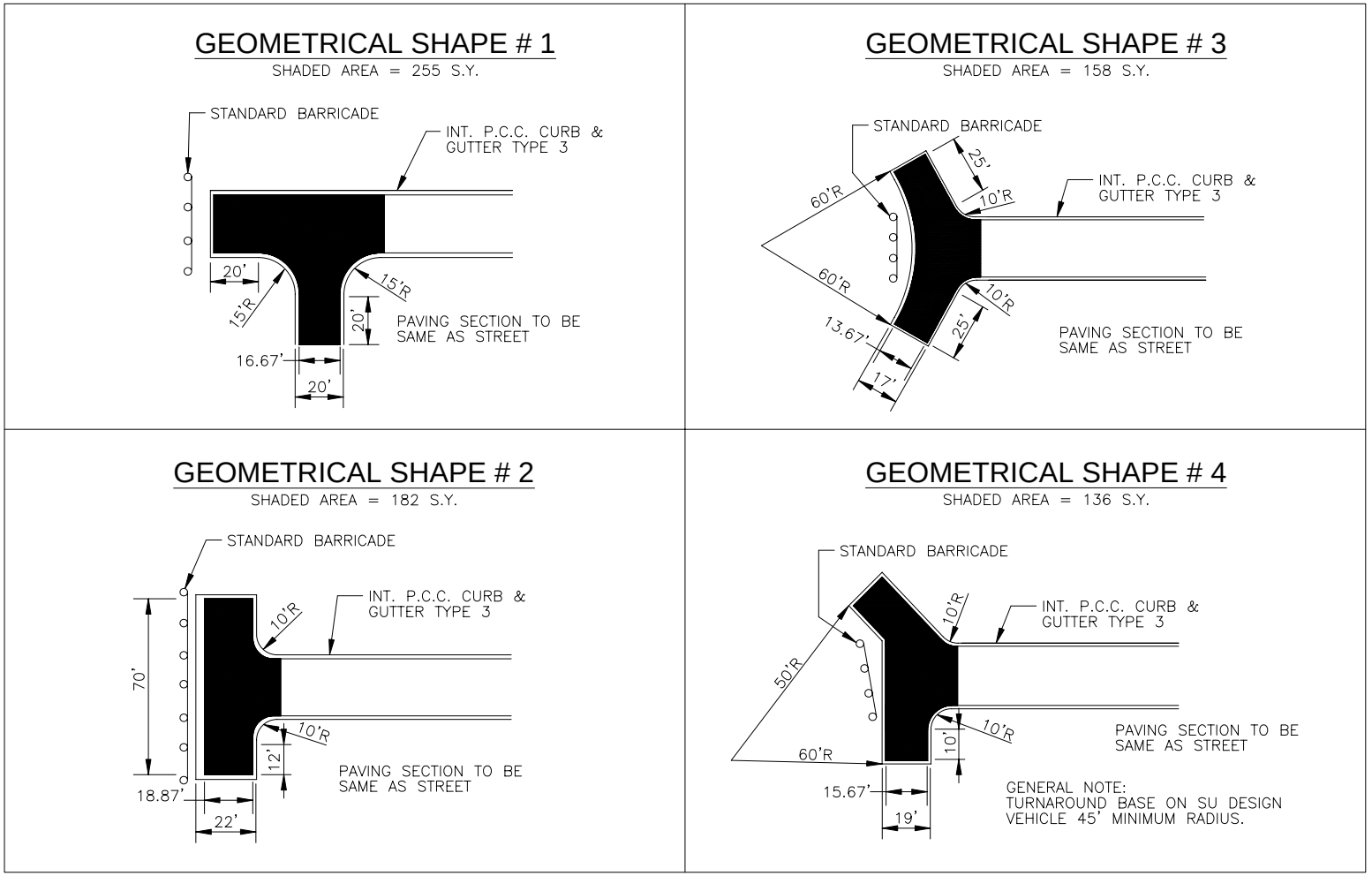


Figure 5-5 Stub Street Signs – Barricade Detail
(Not to Scale)

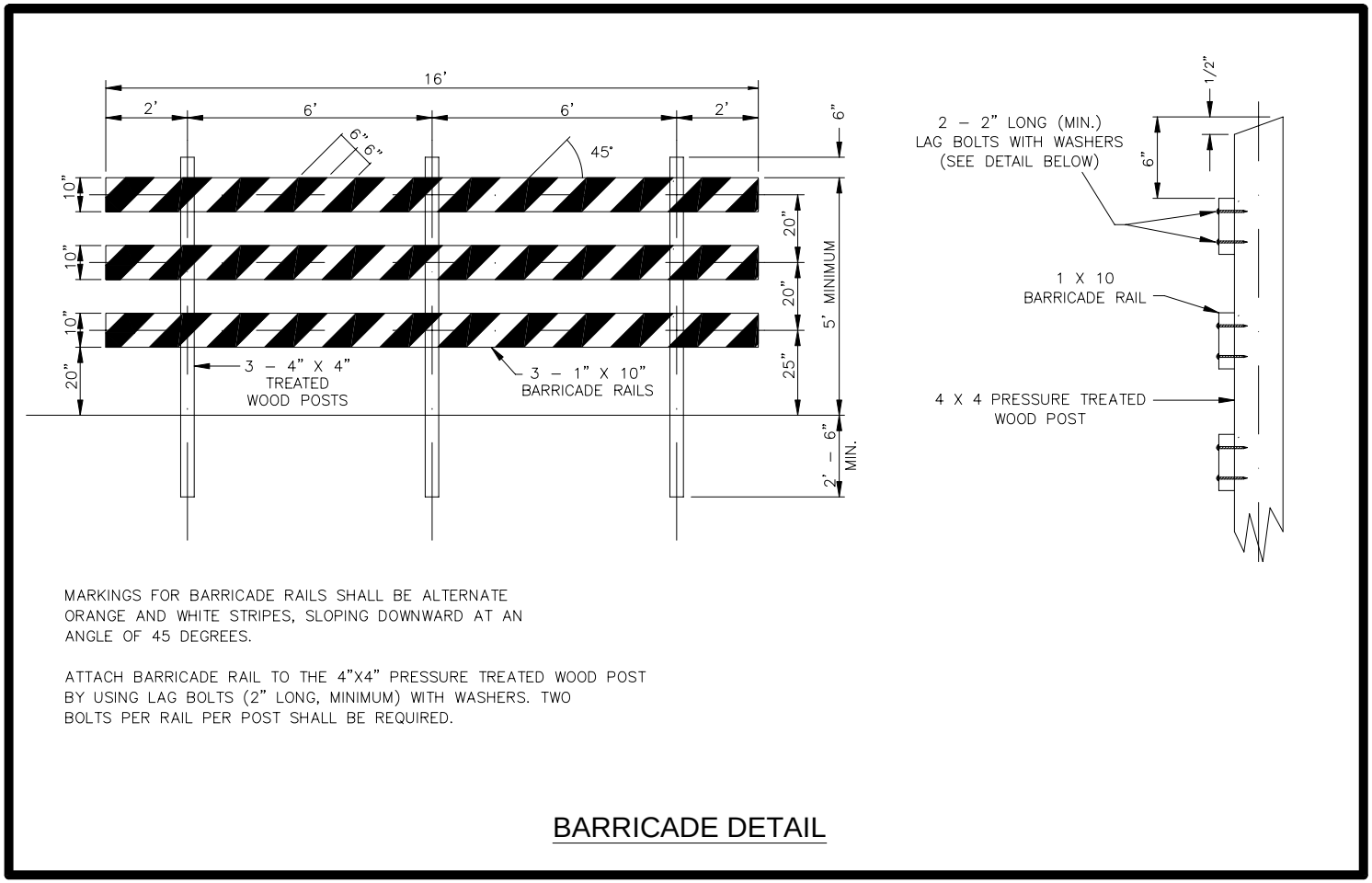


Figure 5-6 Stub Street Signs – Post and Rail Detail
(Not to Scale)

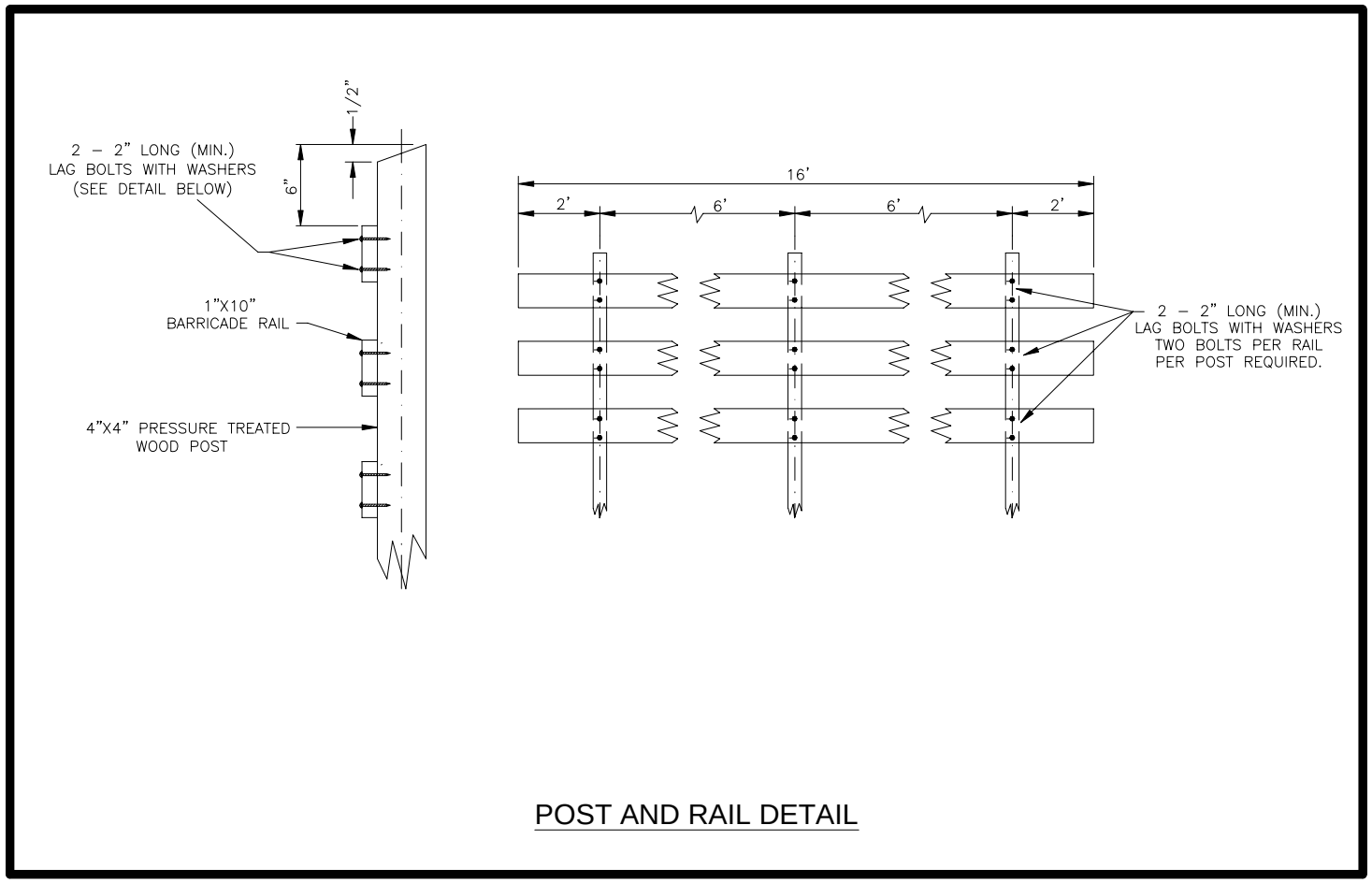
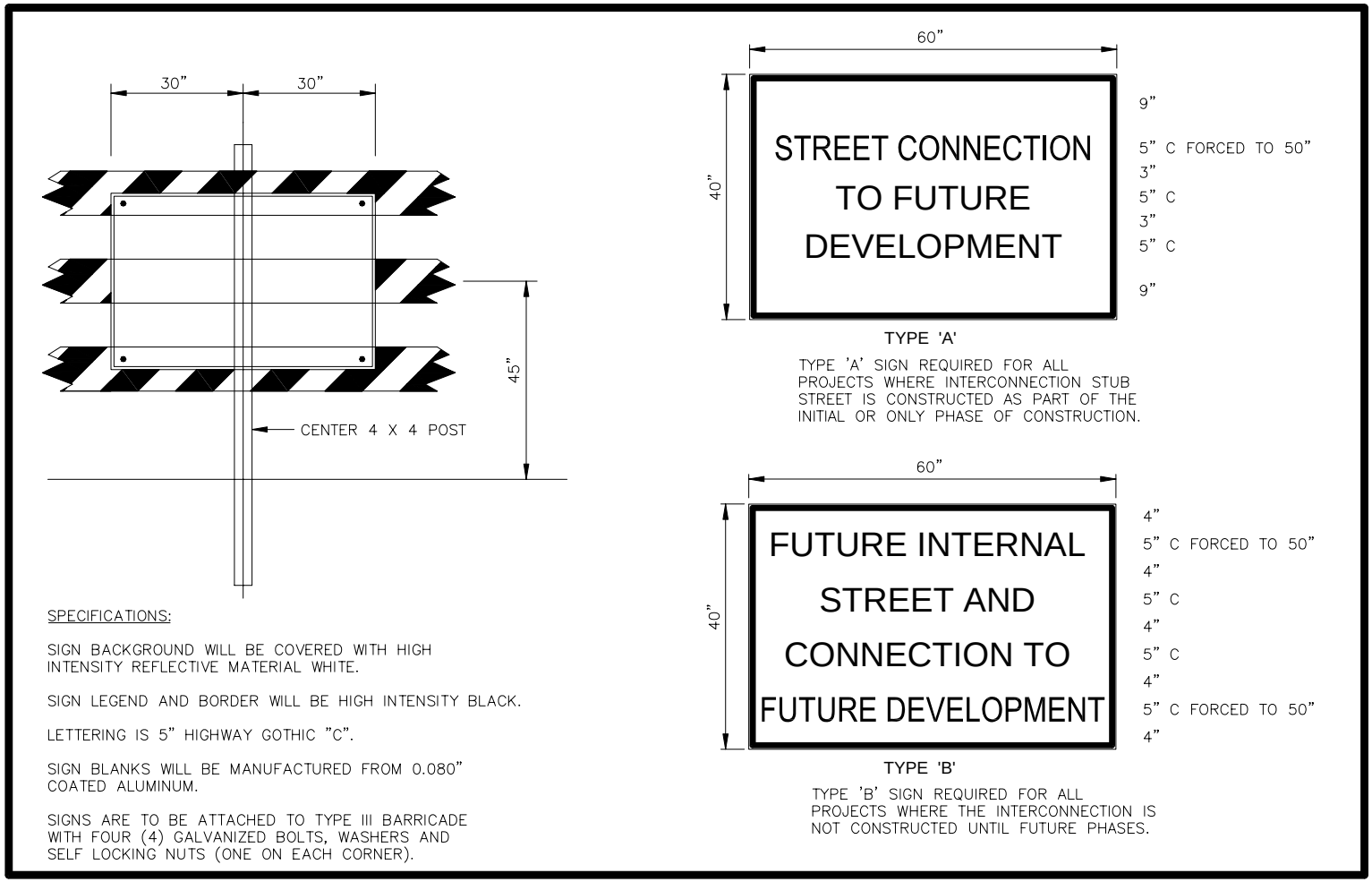


Figure 5-7 Stub Street Sign Detail
(Not to Scale)



5.1.5 SIDEWALKS

Sidewalks are an integral part of DelDOT's infrastructure program. They facilitate and encourage safe and convenient pedestrian travel within communities and among different land uses. They provide safe and reasonable access to public transportation and other alternative modes of transportation, thereby helping alleviate vehicular traffic and reduce emissions. They also reinforce the Americans with Disabilities Act (ADA) by increasing the access opportunity for mobility-impaired individuals. DelDOT requires all subdivision streets to have sidewalks.

All sidewalks and curb ramps are subject to ADA compliance.

5.1.5.1 Placement

In establishing the location of sidewalks, consideration must be given to drainage facilities, sideslopes, new traffic control and signing devices, intersection crossovers, striping, utility appurtenances, mailboxes with posts, and transit stops, in order to avoid conflicts in the design.

For new sidewalks, a minimum width of five feet, not including the width of the top of curb, is required. Wider sidewalks may be preferred or required by local ordinance depending upon the volume and nature of two-way pedestrian traffic. Narrower sidewalks may be allowed subject to consistency with ADA requirements, and surrounding roadside or geographic constraints. A cross slope of 1% is required, with 2% being the maximum.

A buffer between the sidewalk and curb shall be considered. For increased user safety, sidewalks should be as far away from travel lanes as practical. A buffer width of at least five feet between the edge of a sidewalk and the edge of a shoulder, curb, or traveled way is preferred. A five-foot wide strip improves safety, driver comfort, and provides an area for snow removal and mailbox posts.

5.1.5.2 Material

Standard material for any sidewalk or walkway is usually Portland Cement Concrete. However, sidewalk or walkway materials are not limited to Portland Cement Concrete. Upon approval, and when funding is available, more aesthetic materials such as brick, asphalt, or other stable, firm, slip resistant material surfaces may be used. In addition, alternative paving materials that are environmentally sensitive and reduce impervious areas may be used.

Minimum thickness can vary according to materials, but must be at least four inches for Portland Cement Concrete (PCC) on four inches of graded aggregate base course (GABC). A minimum thickness of six inches of PCC and six inches of GABC is required at entrance and driveway areas.

5.1.5.3 Ramps

At intersections, paired perpendicular curb ramps are preferred because they provide an accessible route to enter the crosswalk perpendicular to the travel lane. Single ramps at the intersection radius may only be used in exceptional circumstances, and shall not place the user at risk. A 24 inch long strip of detectable warnings (truncated domes) shall be placed along the full width of the ramp at the transition to the street.

Curb ramps should be sited and oriented to achieve maximum visibility and orientation to the pedestrian path of travel. Driveway entrances should be designed to minimize excessive cross slopes. When a turn must be made to enter or exit a ramp, level landings at the top and bottom of ramps of five feet in width are preferred, with a minimum width of four feet.

For more guidance on sidewalks and curb ramps refer to DelDOT's *Road Design Manual*.

5.1.6 SHARED USE PATH

A shared use path is a facility that is physically separated from the roadway and intended for exclusive use of modes other than motorized vehicles. Initially perceived as bicycle paths, these facilities have grown in popularity, serving bicyclists, in-line skaters, roller skaters, wheelchair users, and pedestrians, including, walkers, runners, people with baby strollers, people walking dogs, etc.

These facilities shall be designed in accordance with the Americans with Disabilities Act standards for shared transportation paths. Maximum slope, cross slope and the rate of change in grade shall be carefully examined during the design process. Because of their multi-use attraction they are a valuable addition to the roadway system and to the range of facilities available to planners and engineers seeking to improve conditions and increase options for all categories of travelers. They can serve both a transportation and recreational function and have proven to be a significant generator of bicycle use. Figure 5-8 shows a layout for a typical two-way shared use path.

Guidance for signing and pavement marking of shared use paths is shown in the MUTCD and the AASHTO publications.

5.1.6.1 Design Criteria

Refer to the DelDOT *Road Design Manual* for the design criteria for shared use paths.

A shared use path should be adequately separated from nearby roadways to prevent operational problems that inconvenience path users. The desirable separation of a shared use path from a roadway is ten feet. The minimum separation of a shared use path from the pavement is five feet. When this minimum is not possible, a crashworthy barrier with a railing system at least 44 inches high should be provided. Refer to AASHTO's *Guide for the Development of Bicycle Facilities* for more guidance.

Two-way shared use paths should be at least 10 feet wide. In high use areas it is recommended to increase the width to 12 feet.

5.1.6.2 Intersections

Intersections with roadways are important safety considerations in shared use path design. There are three basic types of path-roadway intersections: mid-block, adjacent path and complex. If alternate locations are available, the one with the most favorable intersection conditions should be selected.

Mid-block crossings should be located far enough from the intersection to remain outside of the vehicular traffic mix approaching and entering an intersection.

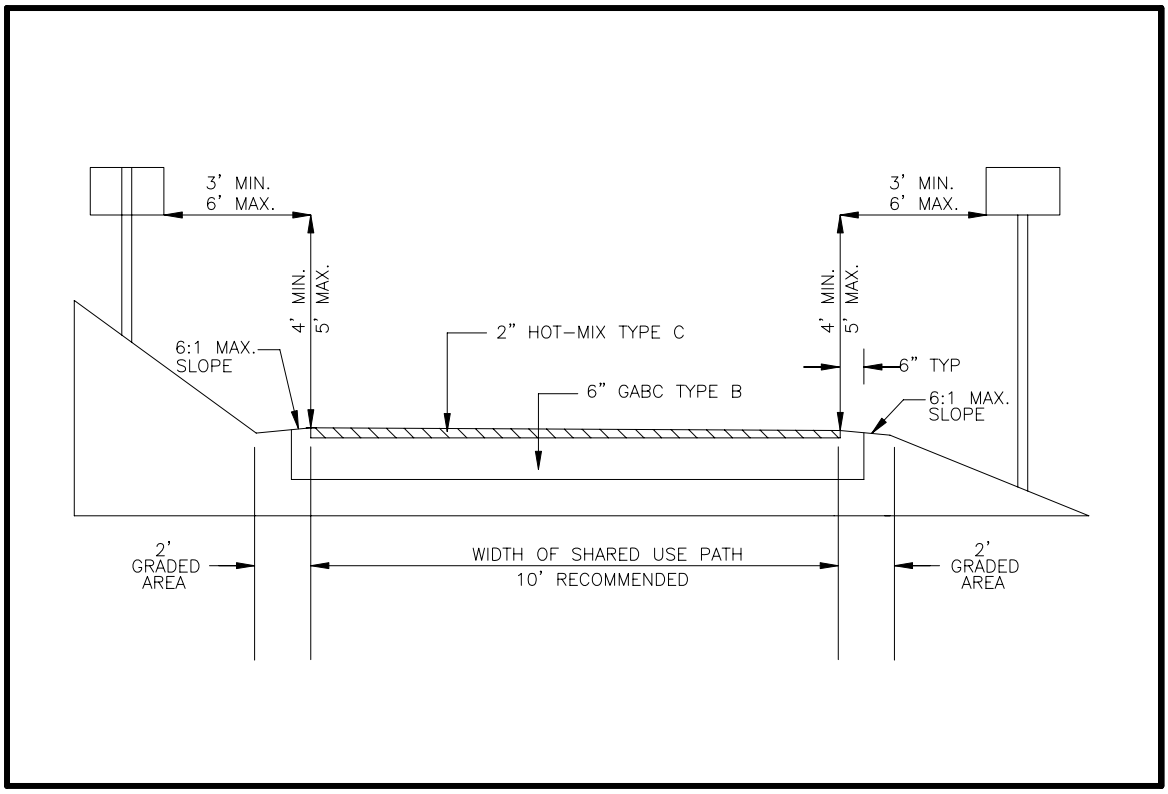
Adjacent path intersections occur when the path is parallel to a roadway and it crosses a driveway or other intersecting roadway such as a T-intersection or a simple four-legged intersection. In designing this type of crossing, it is important to keep the location close to the intersection. This allows the motorist and path user to recognize they are a part of the traffic mix and to be prepared to react accordingly. In this situation, the user is faced with multiple conflicts.

Complex intersections are site-specific and need to be designed to meet the unique issues associated with them.

When shared use paths terminate at existing roads, it is important to integrate the path into the existing system of roadways. Care should be taken to properly design the terminals to transition the traffic into a safe merging or diverging situation. Appropriate signing is required per MUTCD to warn and direct both bicyclists and motorists regarding these transition areas. Bicycle path intersections and approaches should be on relatively flat grades. Stopping sight distances at intersections should be checked and adequate warning should be given to permit bicyclists to stop before reaching the intersection, especially on downgrades.

Curb ramps at intersections should be the same width as the shared use path. Curb ramps should provide a smooth transition between the shared use path and the roadway, and should be concrete.

Figure 5-8 Cross Section – Two Way Shared Use Path
(Not to Scale)



5.1.6.3 Restriction of Motor Vehicle Traffic

Shared use paths need some form of physical barrier at roadway intersections to prevent unauthorized motor vehicles from using the facilities. Provisions can be made for a lockable, removable bollard to permit entrance by authorized vehicles. The bollard should be permanently reflectorized for nighttime visibility and painted a bright color for improved daytime visibility. When more than one bollard is used, five feet of spacing between posts shall be used. Wider spacing can allow entry to motor vehicles, while narrower spacing might prevent entry by adult tricycles and bicycles with trailers.

An alternative method of restricting entry of motor vehicles is to split the entryway into two five-foot wide sections separated by low landscaping. Emergency vehicles can still enter if necessary by straddling the landscaping. The higher maintenance costs associated with landscaping should be considered.

5.1.6.4 Other Design Issues

The preferred pavement surface is a good quality all weather surface. Designing the pavement structure is similar to that of a

roadway. Design is based on soil investigation to determine the load-carrying capacity of the existing soils. In this case, the controlling load is that of motorized maintenance and patrol vehicles. The pavement selection is influenced by frost damage potential, skid resistance, surface quality, edge support, and surface and subsurface drainage.

Drainage design for shared use paths is similar to that of a roadway. A cross slope of 2% in one direction with no crown is preferred and also simplifies the construction. Side ditches, ground cover, erosion and all other drainage design elements are a part of the path design.

5.1.7 TRAFFIC CALMING

The DelDOT Traffic Calming Design Manual (TCDM) provides detailed guidance regarding the appropriate use, design, signing and marking of traffic calming measures approved for use in Delaware. Generally, traffic calming should be an integral part of a site design so as to reduce the need for speed control devices after subdivision construction.

5.2 ENTRANCE DESIGN GUIDELINES

The design elements required for a specific entrance shall be constructed within the existing right-of-way or easements of the roadway. As outlined in Section 3.6, the engineer is responsible for verifying the right-of-way width and that the required improvements can be constructed.

If the right-of-way cannot accommodate the required entrance improvements, the developer can either acquire the necessary right-of-way or reduce the traffic generated from the site to eliminate the need for the improvement. Insufficient right-of-way cannot be the basis for sub-standard design.

Entrance design elements include right-turn lanes, left-turn lanes, and bypass lanes. See Figures 5-9 through 5-11 for typical entrances. Entrance design shall be in accordance with the following guidelines:

1. All entrance-exit facilities shall conform to designs intended exclusively for that purpose. No signs which are contrary to the normal rules of the road (e.g., keep left instead of keep right, etc.) shall be permitted.
2. If pedestrian amenities exist or are placed as part of the land development, the entrance shall be designed to accommodate pedestrians.
3. Median islands shall be permitted in the entrance. The median shall have a maximum width of 12 feet measured from the face of curb. The nose of the median shall be located based on the turning path for the left-turn movement of the design vehicle.
4. All entrance-exit facilities shall be located not only to provide compatibility with the highway system and adjacent entrances, but also to provide good internal circulation once the motorist has left the roadway. The site shall be designed so that traffic will not back-up on the State-maintained roadway.
5. If an entrance is to be controlled by an electronic gating system, the gate shall be located a minimum of 50 feet from the edge of the shoulder.
6. Where feasible, a major entrance-exit facility on one side of a highway shall be located directly across from a major entrance-exit facility on the opposite side of the highway.
7. When a parcel of land is being developed which fronts on a major and a minor roadway, the access to this parcel shall be from the minor roadway and not the major roadway. Exceptions may be considered by the Subdivision Engineer.
8. Roadway width shall be consistent with the type of subdivision street intersecting the roadway. See Figure 5-12.

9. The radius of the entrance shall be established using the turning path of the design vehicle. A minimum 25-foot radius shall be used on all entrances.
10. Profiles of entrances and exits shall be designed in accordance with these *Standards and Regulations for Subdivision Streets and State Highway Access*, and AASHTO's standards. Maximum grades shall not exceed 8%. Vertical curve transition shall be provided at the intersection of the driveway profile and the cross slope of roadway shoulder extended.
11. All parking and unparking maneuvers within the immediate area of a commercial entrance shall be avoided. These maneuvers shall not block the entrance and cause the backing-up of traffic onto the highway.
12. No driveways or parking bays shall be located within 40 feet from the edge of shoulder or pavement of any type of functional classification roadway.
13. A motorist's tendency is to follow pavement joint lines instead of the painted lines which denote the actual travel lanes. A conflict between the pavement joints and travel lanes shall be avoided. If this conflict occurs, the pavement shall be covered with a layer of asphalt paving.
14. The minimum distance between the intersection radius of the entrance with the State-maintained roadway shoulder and the property line of the adjacent property is 5 feet.
15. Spacing of entrances shall comply with the requirements outlined in Chapter 9.
16. At signalized intersections, sufficient storage length shall be provided on all left-turn lanes, and on all right-turn lanes that are controlled by separate signal heads (right-turn arrows), to accommodate the 95th percentile queues for those movements and to prevent those lanes from being blocked by the 95th percentile queues in the through lanes. Queue lengths shall be determined through Highway Capacity Software (HCS) analyses of the morning and evening weekday peak hours of the street where the entrance is located. For uses where other peak hours are relevant, e.g. the Saturday midday peak hour for shopping centers, or shift changes for factories, additional analyses may be required.

Figure 5-9 Typical Entrance I

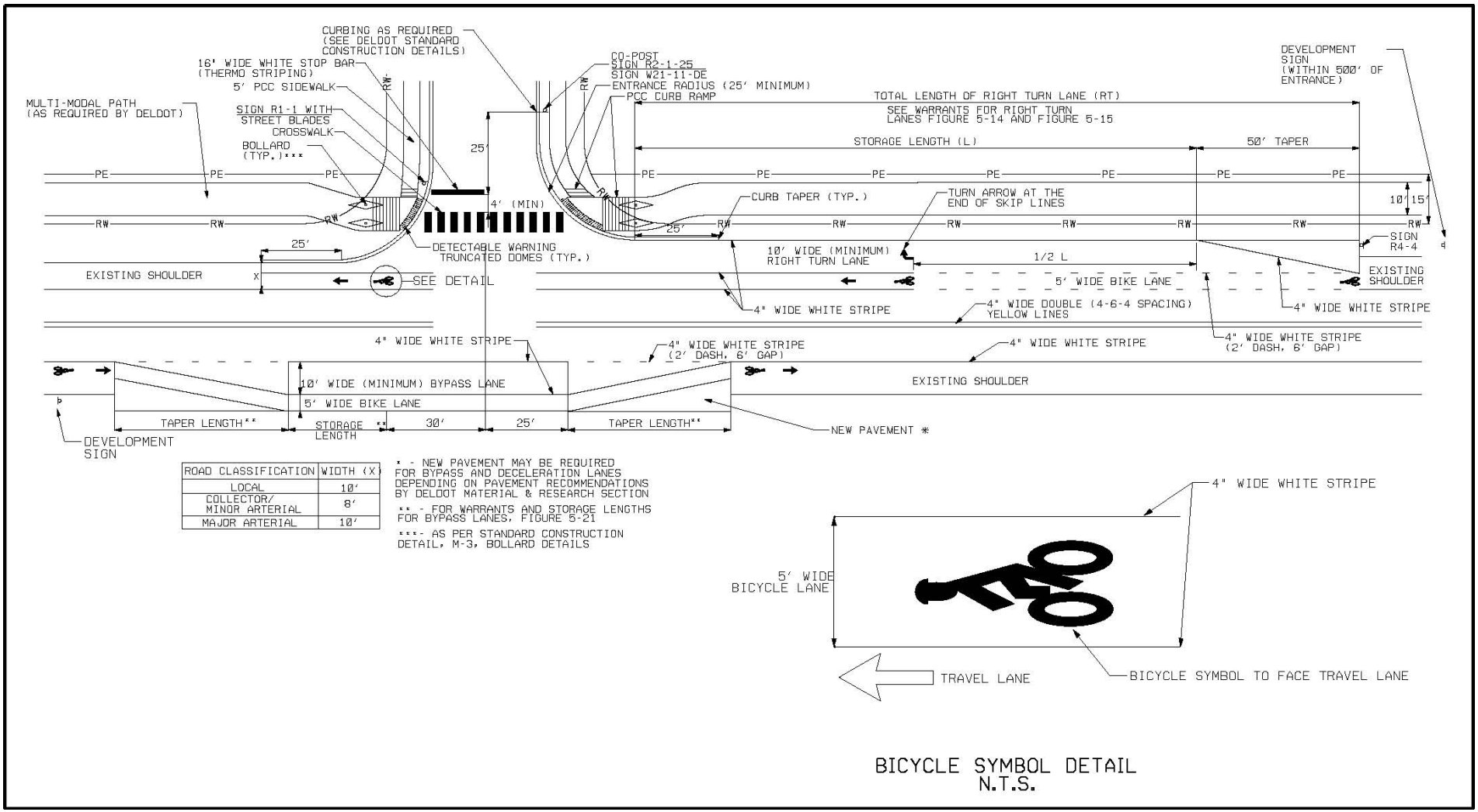


Figure 5-10 Typical Entrance II - Entrance Location for Corner Properties

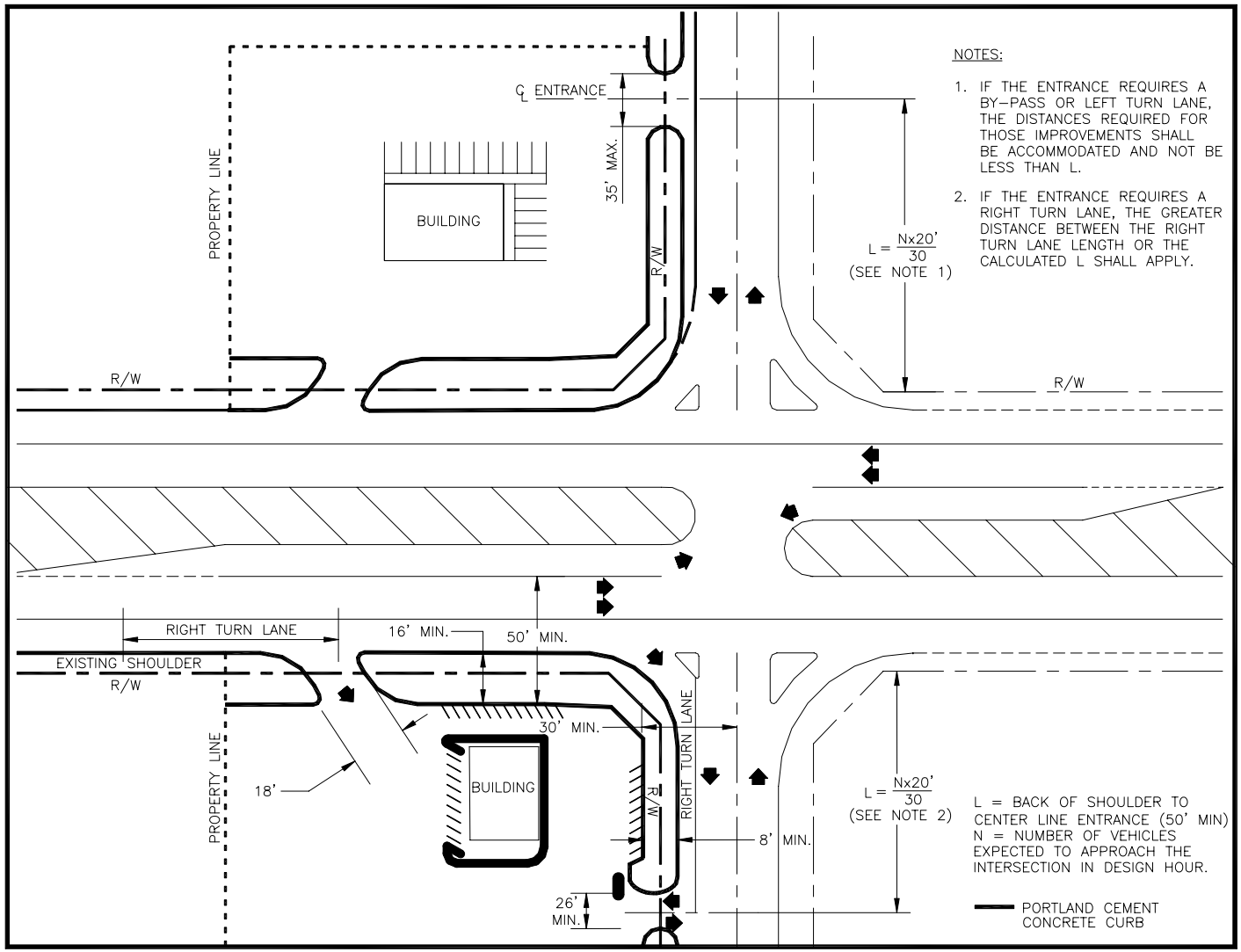
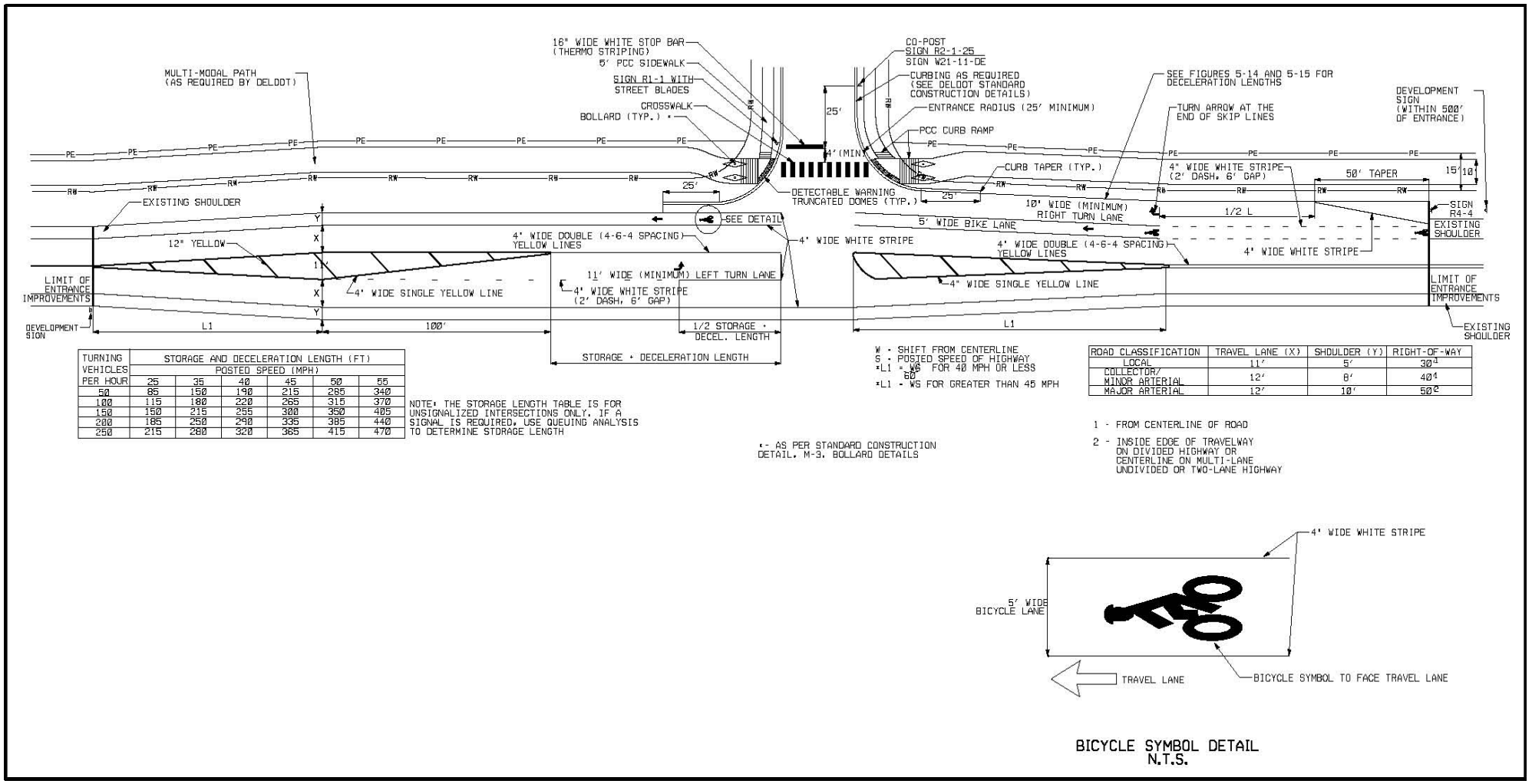


Figure 5-11 Typical Entrance III



TURNING VEHICLES PER HOUR	STORAGE AND DECELERATION LENGTH (FT) POSTED SPEED (MPH)					
	25	35	40	45	50	55
50	85	150	190	215	285	340
100	115	180	220	265	315	370
150	150	215	255	300	350	405
200	185	250	290	335	385	440
250	215	280	320	365	415	470

NOTE: THE STORAGE LENGTH TABLE IS FOR UNSIGNALIZED INTERSECTIONS ONLY. IF A SIGNAL IS REQUIRED, USE QUEUING ANALYSIS TO DETERMINE STORAGE LENGTH

W - SHIFT FROM CENTERLINE
S - POSTED SPEED OF HIGHWAY
*L1 = $\frac{WS}{60}$ FOR 40 MPH OR LESS
*L1 - WS FOR GREATER THAN 45 MPH

* - AS PER STANDARD CONSTRUCTION DETAIL, M-3, BOLLARD DETAILS

ROAD CLASSIFICATION	TRAVEL LANE (X)	SHOULDER (Y)	RIGHT-OF-WAY
LOCAL	11'	5'	30[1]
COLLECTOR/ MINOR ARTERIAL	12'	8'	40[1]
MAJOR ARTERIAL	12'	10'	50[2]

1 - FROM CENTERLINE OF ROAD

2 - INSIDE EDGE OF TRAVELWAY ON DIVIDED HIGHWAY OR CENTERLINE ON MULTI-LANE UNDIVIDED OR TWO-LANE HIGHWAY

BICYCLE SYMBOL DETAIL
N.T.S.

Figure 5-12 Entrance Pavement Widths

Subdivision Street	Pavement Width (With Curb and Gutter)	Pavement Width (Without Curb and Gutter)
Type I, II, and III (With Median)	16 feet	18 feet
Type I (Without Median)	22 feet	22 feet
Type II and III (Without Median)	32 feet	32 feet
Industrial Streets	32 feet	32 feet
Commercial Access (1-way)	18 feet	18 feet
Commercial Access (2-way)	24 feet	30 feet

Notes:

1. *If wider pavements are needed, a plan showing the turning path of the design vehicle must be provided.*
2. *If multiple lanes of ingress / egress are required to satisfy the capacity needs of the development, the design must be approved by the Subdivision Engineer.*

5.2.1 BIKE ACCOMMODATION AT ENTRANCES

At intersections, bicyclists proceeding straight through and motorists turning right will cross paths. Striping and signing configurations that encourage these crossings in advance of the intersection, in a merging fashion, are preferable to those that force the crossing in the immediate vicinity of the intersection. Site entrance designs must accommodate bicycle traffic.

The design of a bike lane needs to include appropriate pavement markings and signing approaching and through intersections to reduce the number of conflicts. Guidance for signing and pavement marking of bike lanes is shown in the MUTCD and AASHTO's G*uide for the Development of Bicycle Facilities.*

A bike lane should be delineated to indicate the separation from the motor vehicle travel lanes with a four-inch wide solid white line. Adequate pavement surface, bicycle-safe grate inlets, and safe railroad crossing shall be provided on roadways where bicycle lanes are being designated. Raised pavement markings and raised barriers can cause steering difficulties for bicyclists and should not be used to delineate bicycle lanes.

5.2.2 AUXILIARY LANES

Auxiliary lanes provide an area for traffic to maneuver outside of the through lanes to improve safety and capacity of the roadway. Auxiliary lanes include right-turn lanes, left-turn lanes, bypass lanes and crossovers. For unsignalized intersections, the length of auxiliary lanes depends on local conditions, 10-year projected traffic volumes (from the date of submission), traffic mix, design speed, posted speed, selected level of service, and operating speeds.

5.2.2.1 Right-Turn Lane

Separate right-turn lanes shall be required when warranted in accordance with Figure 5-13 and 5-14. Projected volumes (10-year) shall be used for the analysis. Right-turns can be free flowing, yield or stop-controlled. In order to

operate properly, free flowing right-turn lanes must have an adequate deceleration distance with no access points for drivers to safely merge with and diverge from the through traffic.

5.2.2.2 Left-Turn Lane

Separate left-turn lanes shall be required on two-lane, two-way roadways and divided highways when warranted. When it is determined that a project located on a divided highway shall generate sufficient number of left-turns to warrant the construction of a left-turn lane, it shall be the responsibility of the developer to construct a left-turn lane at the locations designated by DelDOT.

A separate left-turn lane shall be required for all unsignalized subdivision entrances located on undivided highways in accordance with the warrants for left-turns lanes found in Figures 5-15 through 5-18. Projected volumes (10-year) shall be used for Figures 5-13 through 5-18. If the percent distribution of left-turns in the advancing volume during the peak hour is greater than the percentage shown on the intersecting line, a left-turn lane is warranted.

A separate left-turn lane shall be required for all signalized subdivision entrances located on undivided highways in accordance with the most current Highway Capacity Manual guidelines. Projected volumes (10-year) shall be used for the analysis.

When access to a proposed site requires vehicles to utilize an existing left-turn lane, the developer shall perform an operational analysis to determine if there is sufficient storage length. The developer will be required to make any modifications necessary to provide an adequate left-turn lane.

Left-turn lanes may be required when physical characteristics restrict sight distance below AASHTO standards.

Left-turn lanes may be required at age-restricted communities where there is a need to accommodate older drivers.

The pavement design for all left-turn lanes on two-lane, two-way roadways shall be comparable in design to the existing traveled way.

5.2.2.3 Bypass Lane

A bypass lane is a paved shoulder that permits through traffic to bypass a left-turning vehicle which is stopped on the travel lane. They are intended to reduce delay and expedite the movement of through traffic at T-intersections.

An intersection shall be considered for a separate left turn lane first using the warrants outlined in Figures 5-15 through 5-18. If those warrants are not met then consideration should be given for a by-pass lane. Bypass lanes shall be designed in accordance with Figure 5-20. Projected volumes (10-year) shall be used for the analysis. A five foot shoulder shall be provided on the outside of the bypass lane to accommodate bicycles.

Bypass lanes will not be permitted in the following locations. If a by-pass lane is warranted in these locations then a separate left turn lane shall be constructed in accordance with these standards.

- On roads with a Functional Classification of Major Collector or higher.
- Where an existing entrance or State-maintained street lies within the limits of the proposed bypass lane.

5.2.2.4 Crossovers

Crossovers are median openings designed to accommodate U-turn vehicles. Crossovers are provided on divided highways at intervals that serve adjacent properties without greatly inconveniencing property owners and other users.

Crossover design at two-lane crossroads or connecting roads shall be in accordance with standard crossover design found in AASHTO's

Policy on Geometric Design of Highways and Streets (The Green Book).

The following general guidelines shall be used:

1. Additional crossovers shall not be placed, regardless of existing spacing on highways, where DelDOT has determined that crossovers should not be added for reasons of safety or capacity.

2. Crossovers shall not be placed on limited access highways under any circumstances.

3. It is desirable to maintain an average spacing of 1000 to 1500 feet at crossovers in urban areas and 2000 to 3000 feet at crossovers in rural areas.

4. Closer spacing shall be permitted when DelDOT finds it beneficial for traffic operations and safety.

5. The absolute minimum spacing of crossovers shall be governed by the requirements for left-turn lanes to include required taper lengths, deceleration lengths and storage lengths.

6. DelDOT may remove crossovers when warranted by changes in surrounding land use or when necessary for traffic operation and safety.

7. Minimum crossover width is 40 feet. The crossover width may be increased as required by the intersecting roadway or entrance condition.

8. The pavement design for all crossovers shall be based on anticipated traffic and soil conditions. Figure 5-19 shows a typical crossover design.

5.3 BICYCLE FACILITIES

Suitable accommodations for bicyclists shall be required for all subdivision and commercial site plans. See Figure 5-21 for typical bike lane cross sections.

Unless access is specifically denied, some level of bicycle use can be anticipated on most roadways. All new roadways, except those where bicyclists shall be legally prohibited, should be designed and constructed to encourage use of bicycles as a form of transportation. Guidelines are presented here to help design and construct roadway improvements and separate facilities that accommodate the operating characteristics of bicycles. Additional information including signing layouts, striping, and design details can be found in AASHTO's *Guide for the Development of Bicycle Facilities.*

Figure 5-13 Right-Turn Lane Warrants (R ≤ 50')

Roadway ADT	Right-Turn ADT	Assumed Speed Change on Through Lane	Highway Posted Speed					
			25 MPH	35 MPH	40 MPH	45 MPH	50 MPH	55 MPH
			Decel Length	Decel Length	Decel Length	Decel Length	Decel Length	Decel Length
ADT Less Than 2,000	0 – 100	Full Reduction	–	–	–	–	–	–
	101 – 200	25 MPH	–	150	150	150	175	220
	Over 200	20 MPH	150	150	150	175	220	270
2,000 to 4,000 Vehicles	0 – 100	Full Reduction	–	–	–	–	–	–
	101 – 200	25 MPH	–	150	150	150	175	220
	201 – 300	20 MPH	150	150	150	175	220	270
	301 – 400	15 MPH	150	150	180	225	275	330
	Over 400	10 MPH	150	190	235	285	340	395
4,001 to 10,000 Vehicles	0 – 50	Full Reduction	–	–	–	–	–	–
	51 – 100	20 MPH	150	150	150	175	220	270
	101 – 200	15 MPH	150	150	175	220	270	325
	201 – 400	10 MPH	150	180	225	275	315	385
	Over 400	5 MPH	150	235	285	340	395	460
Over 10,000 Vehicles	0 – 50	Full Reduction	–	–	–	–	–	–
	51 – 100	15 MPH	150	150	175	220	270	325
	101 – 200	10 MPH	150	175	220	270	325	380
	201 – 400	5 MPH	150	225	275	330	385	450
	Over 400	0 MPH	190	285	340	395	460	530

***Note:** All decel lengths include a 50-foot taper length.*
Factors to consider include sight distance, vertical grades, and driver population.
* Note: The storage length table is for unsignalized intersections only. If a signal is required, use queuing analysis to determine the storage lengths

Figure 5-14 Right-Turn Lane Warrants (R > 50')

Roadway ADT	Right-Turn ADT	Assumed Speed Change on Through Lane	Highway Posted Speed					
			25 MPH	35 MPH	40 MPH	45 MPH	50 MPH	55 MPH
			Decel Length*	Decel Length	Decel Length	Decel Length	Decel Length	Decel Length
Less Than 2,000	0 – 100	Full Reduction	–	–	–	–	–	–
	101 – 200	25 MPH	–	135	135	135	155	200
	Over 200	20 MPH	135	135	135	155	200	250
2,000 to 4,000 Vehicles	0 – 100	Full Reduction	–	–	–	–	–	–
	101 – 200	25 MPH	–	135	135	135	155	200
	201 – 300	20 MPH	135	135	135	155	200	250
	301 – 400	15 MPH	135	135	155	200	250	305
	Over 400	10 MPH	135	155	300	250	305	360
4,001 to 10,000 Vehicles	0 – 50	Full Reduction	–	–	–	–	–	–
	51 – 100	20 MPH	135	135	135	155	200	250
	101 – 200	15 MPH	135	135	155	200	250	305
	201 – 400	10 MPH	135	155	200	250	305	360
	Over 400	5 MPH	135	200	250	305	360	425
Over 10,000 Vehicles	0 – 50	Full Reduction	–	–	–	–	–	–
	51 – 100	15 MPH	135	135	155	200	250	305
	101 – 200	10 MPH	135	155	200	250	305	360
	201 – 400	5 MPH	135	200	250	305	360	425
	Over 400	0 MPH	155	250	305	360	425	495

* Factors to consider include sight distance, vertical grades, and driver population.
* Note: The storage length table is for unsignalized intersections only. If a signal is required, use queuing analysis to determine the storage lengths Note : All decel lengths include a 50-foot taper length.

Figure 5-15 Left-Turn Lane Warrants at Unsignalized Intersections – 25 MPH

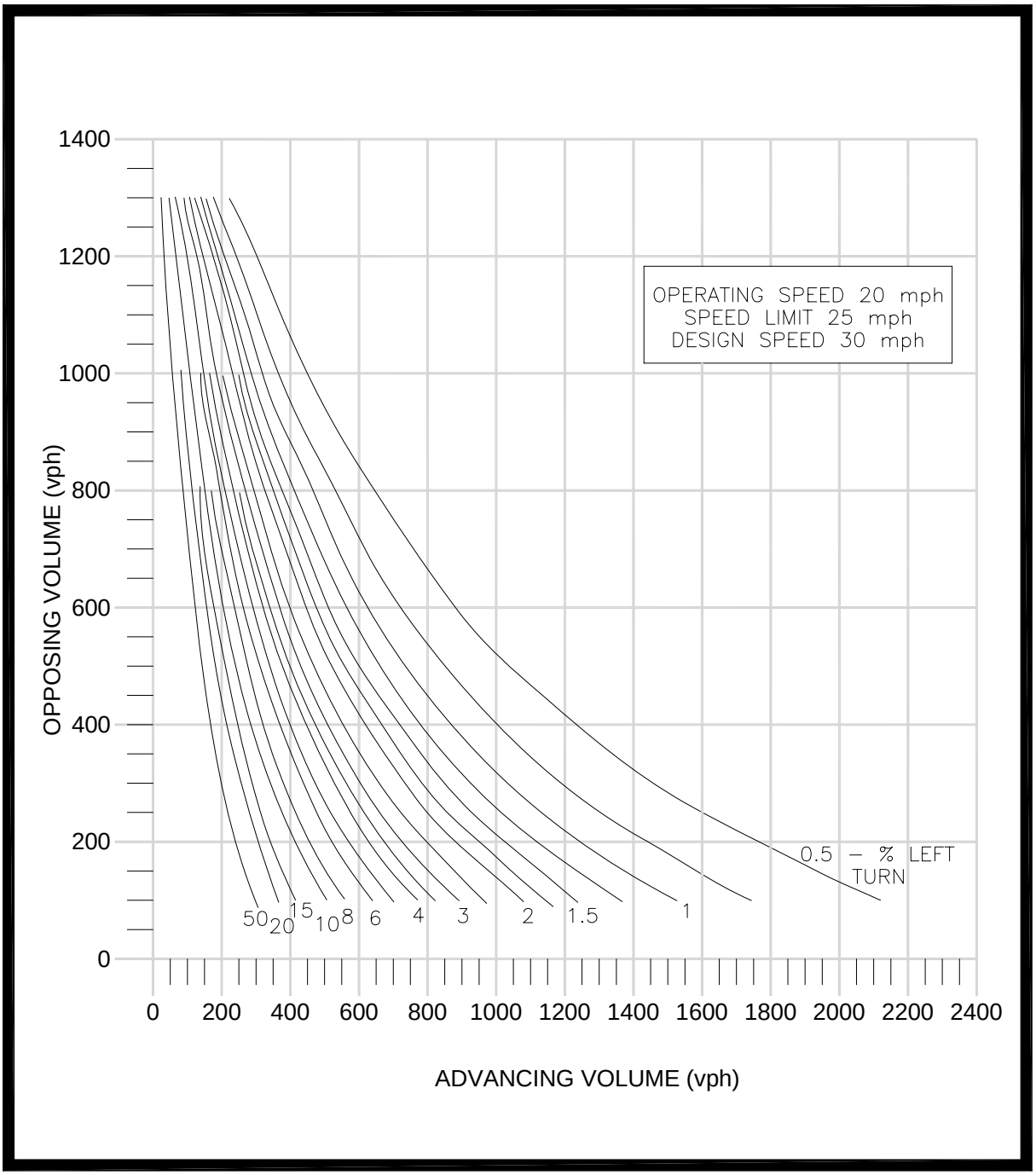


Figure 5-16 Left-Turn Lane Warrants at Unsignalized Intersections – 35 MPH

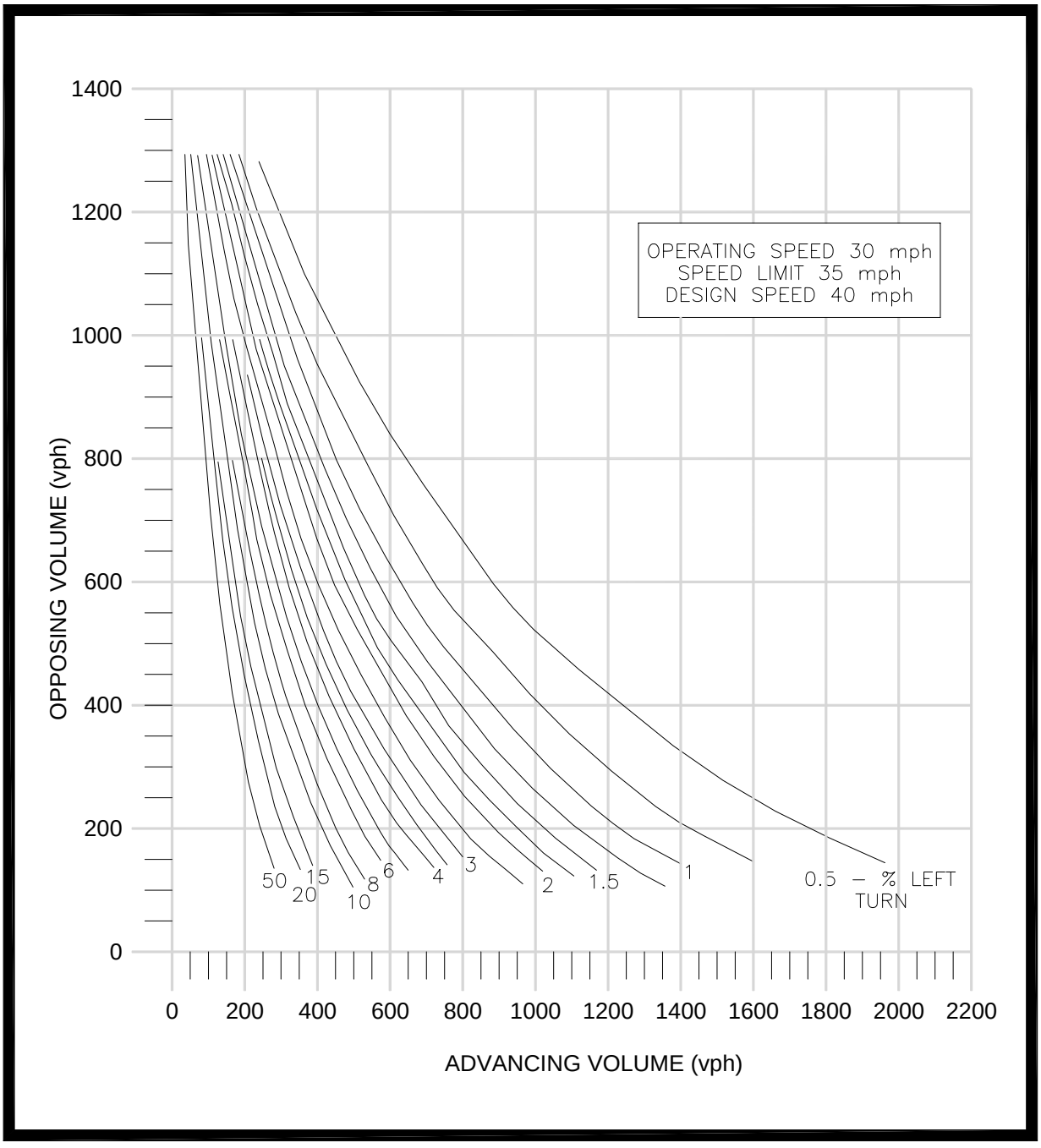


Figure 5-17 Left-Turn Lane Warrants at Unsignalized Intersections – 45 MPH

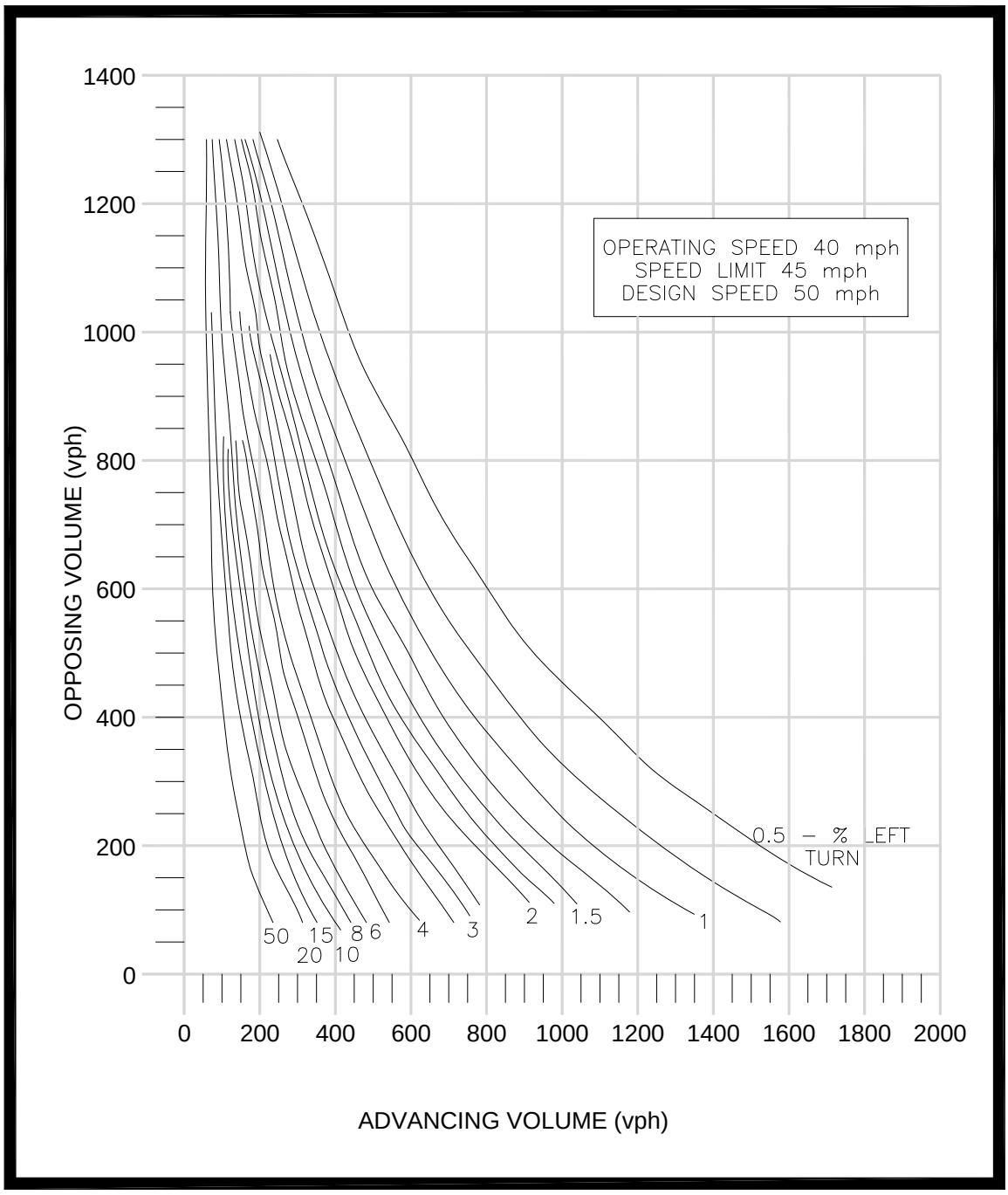


Figure 5-18 Left-Turn Lane Warrants at Unsignalized Intersections – 55 MPH

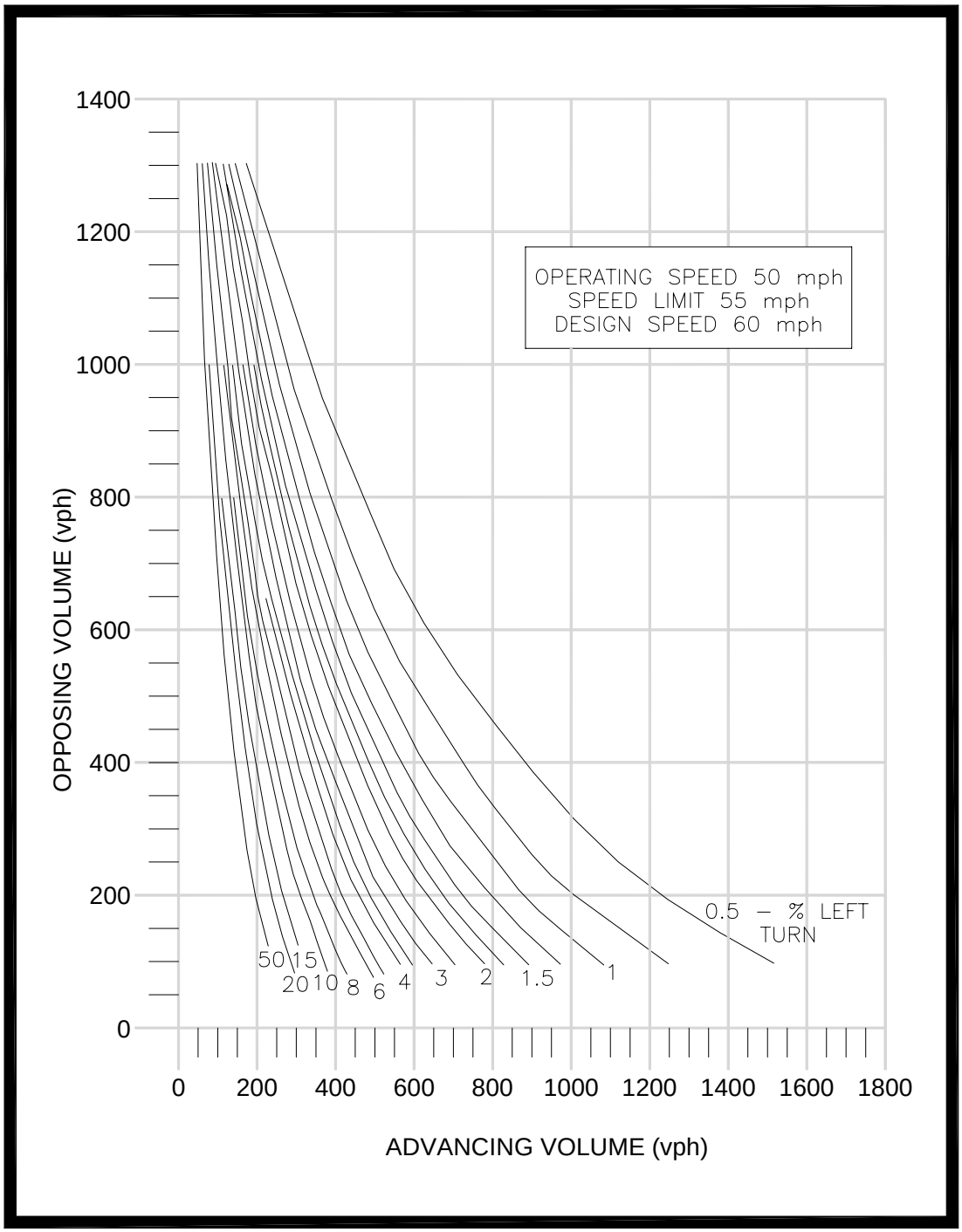


Figure 5-19 Typical Turning Lane Design for Divided Highways

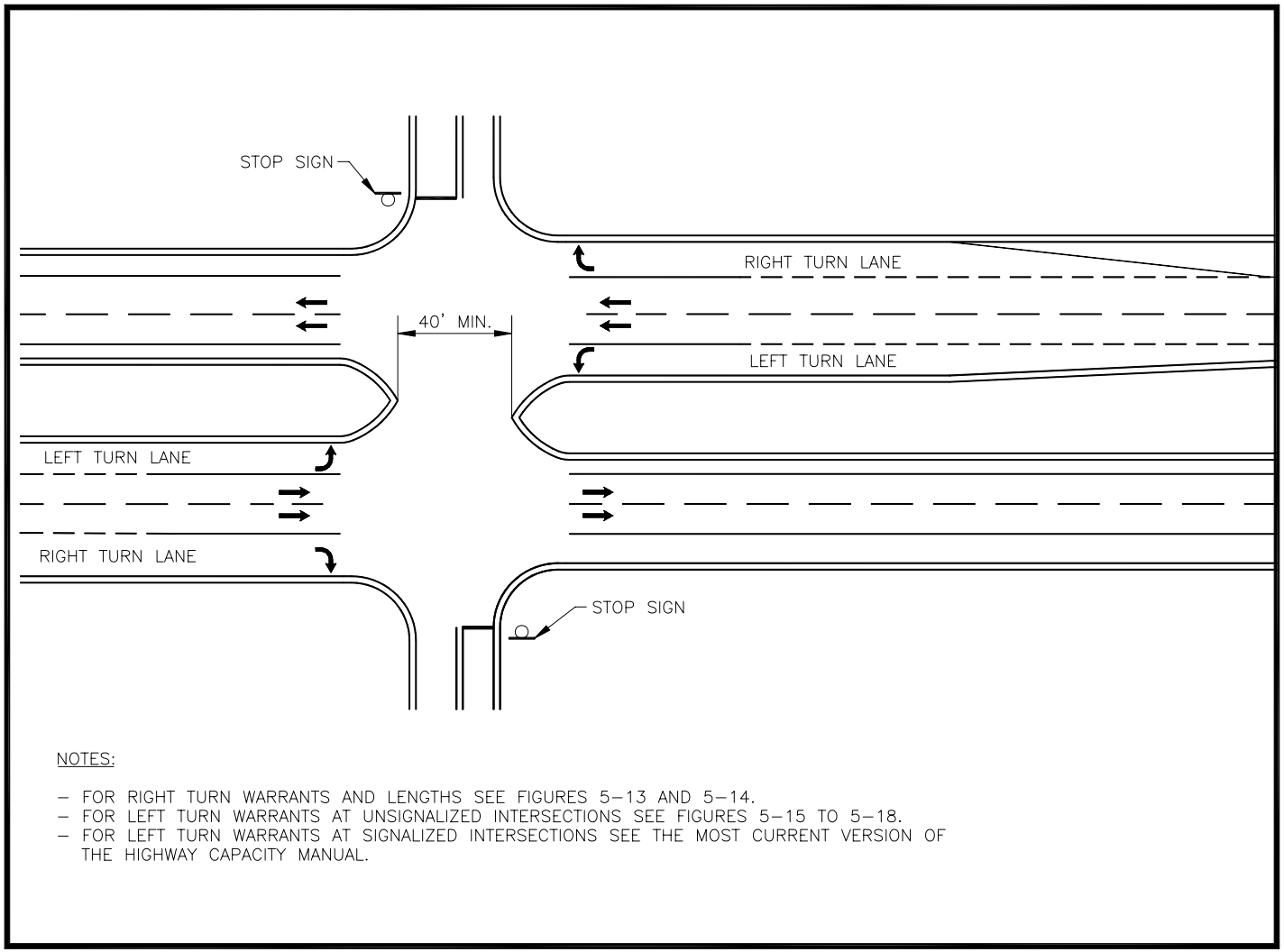


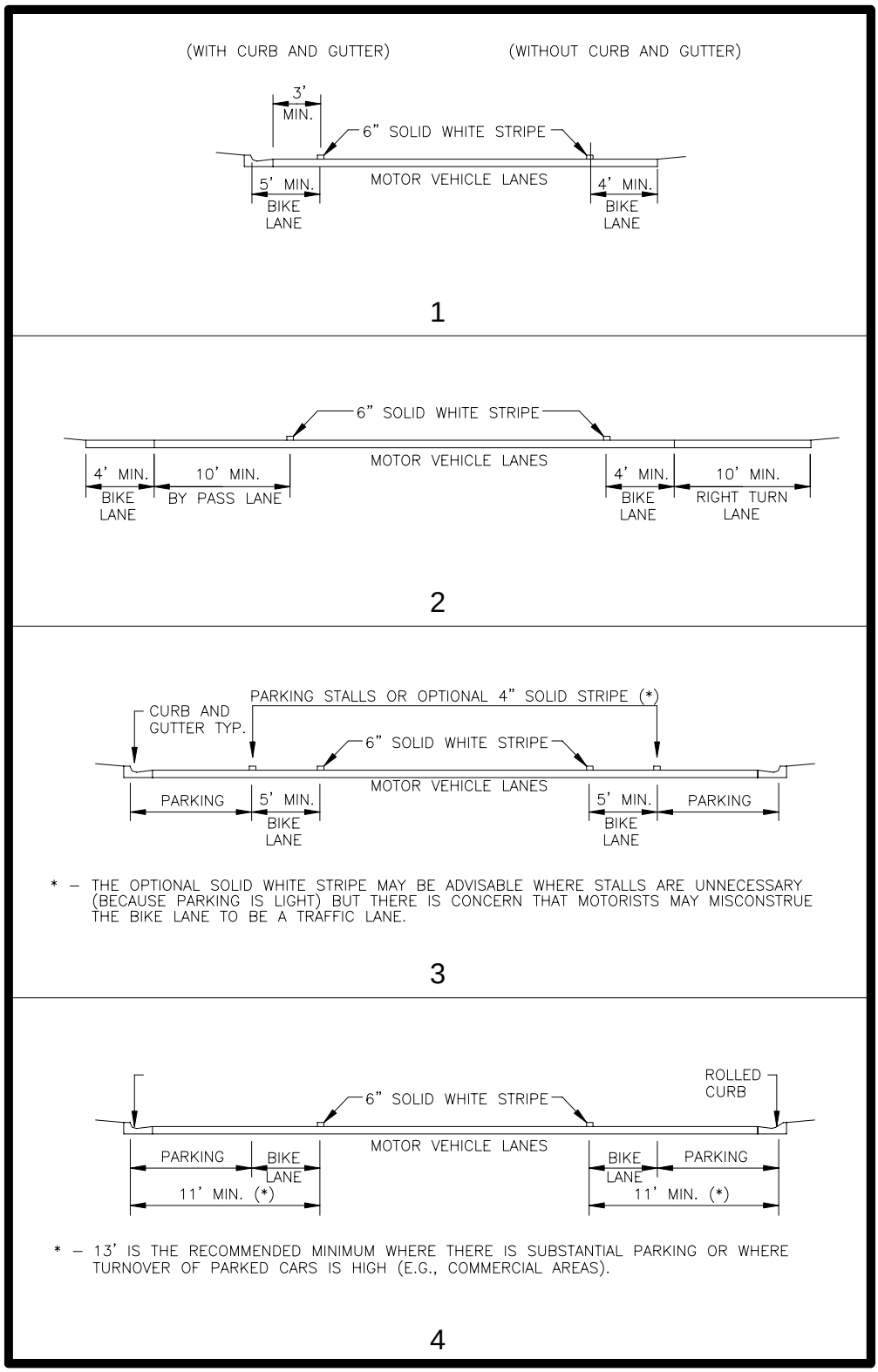
Figure 5-20 Length of Bypass Lanes for Two Lane Highways

Roadway ADT	Left-Turn ADT	Storage Length (feet)	Taper Length (feet)					Assumed Speed Change on Through Lane
			Highway Posted Speed					
			25 MPH	35 MPH	40 MPH	45 MPH	50 MPH	
Less Than 2,000 Vehicles	0 – 50	–	–			–	–	–
	51 – 200	–	–			–	–	–
	Over 200	40	50	50	50	60	75	25
2,000 to 4,000 Vehicles	0 – 100	–	–			–	–	–
	101 – 200	40	50	50	50	60	75	25
	201 – 300	60	50	50	60	75	100	20
	301 – 400	80	50	60	75	100	125	15
	Over 400	Consider Separate Left-Turn Lane*						
Over 4,000 Vehicles	0 – 50	–	–			–	–	–
	51 – 100	20	50	50	60	75	100	20
	101 – 200	40	50	60	75	100	125	15
	201 – 400	80	50	75	100	125	150	10
	Over 400	Consider Separate Left-Turn Lane*						

Notes:

* See warrants for left-turn lane

Figure 5-21 Typical Bike Lane Cross Sections



5.4 SIGHT DISTANCE

When an entrance is provided to a State-maintained roadway, the area adjacent to right-of-way shall be clear and free of obstructions. When approaching an intersection, a driver should have an unobstructed view of the intersecting roadway and the ability to view any approaching vehicles at the intersection.

1. The entrance location and design shall provide a clear line-of-sight for the driver of a vehicle preparing to enter the roadway in accordance with AASHTO location and design standards.

2. The departure sight triangle (see Figure 5-22) shall be used at entrances where a stopped driver on a minor road approach (entrance) attempts to depart from the intersection and enter or cross a major road. Calculated distance from center of travel lane to 10 feet behind stop bar ((a) in Figure 5-22)) shall be used as the decision point in departure sight triangle.

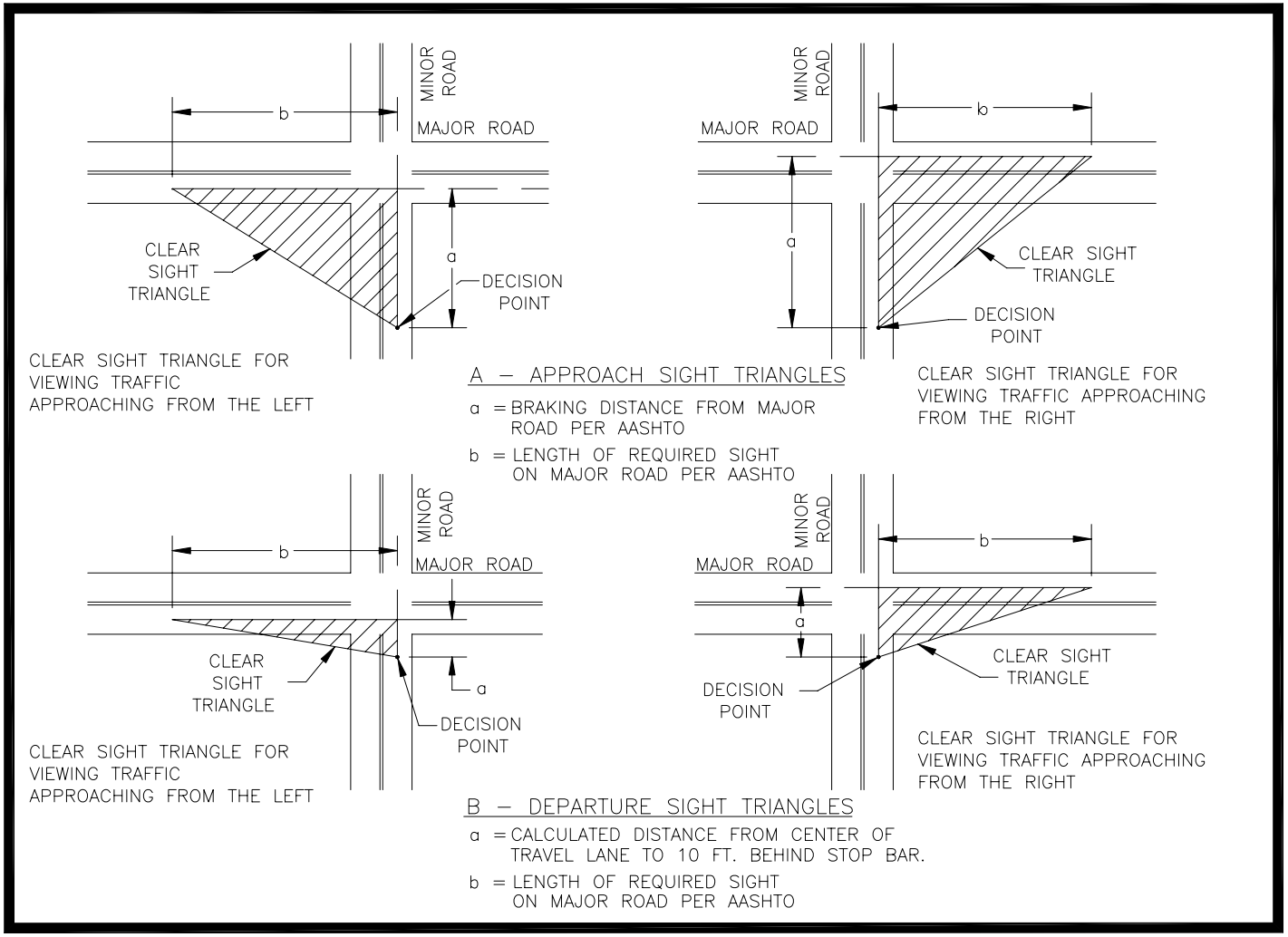
3. Any marquee sign located in conformance with the "Outdoor Advertising" requirements must be placed to maintain the required sight distance.

4. If the sight triangle established in accordance with the AASHTO standards is outside the existing right-of-way an easement shall be established to maintain the required sight distance. See Figure 5-22.

5. At subdivision entrances, the sight triangle shall be maintained and be free of plantings that could obstruct the sight distance.

6. Within the streets of a subdivision the placement of shrubbery or other visual barriers is prohibited within the triangular area formed by the intersection of two curb lines and a line joining the respective points on each of these lines at a distance of 30 feet from the point of intersection. These triangular areas shall be designated on the site plans as sight triangle easements. DelDOT shall have full authority to maintain the required sight distance. Fire hydrants shall not be considered visual barriers or hazardous obstacles.

Figure 5-22 Sight Distance Triangles



5.5 TYPICAL SECTIONS

1. Subdivision Streets – Typical sections for subdivision streets define the roadway width and cross slopes, stormwater runoff accommodations (curbs or ditches/ sideslopes), and clear zones.

2. State-maintained Roadways – If an entrance requires any modification or improvement on the State-maintained roadway, a typical section shall be required. The typical section shall show the proposed pavement widths and sideslopes as outlined in this section.

5.5.1 PAVEMENT WIDTHS

1. Subdivision Streets – Pavement widths vary for each subdivision street. See Figures 5-23 through 5-25 for typical sections.

2. State-maintained Roadways – The width of auxiliary lanes associated with the entrance design shall be a minimum of ten feet in width. If accommodations are being made for bikes on the facility, the width of the auxiliary lane shall be increased to a minimum width of 15 feet. The lateral offset of an auxiliary lane shall accommodate a minimum 11-foot wide through lane.

5.5.2 CURBS

Curbing may be used on subdivision streets to accommodate stormwater runoff. When the design velocity of an open ditch section exceeds 4 ft./sec., a curb and gutter system shall be used. Refer to the DelDOT *Standard Construction Details* for acceptable curb types.

A minimum of six inches of GABC type B shall be placed under all curbs and shall extend six inches beyond the back of curb.

Curbs shall be used for all entrances and islands located in the following areas:

- On all collectors and arterials as shown on DelDOT's Functional Classification Map.
- In municipalities and urban areas.
- Where the existing highway is curbed.
- Where necessary to control access.

The type of curb to be used must be shown on the entrance drawing. Where the existing roadway is not curbed, the islands and curbs shall be placed no closer than ten feet from the edge of the roadway. Where the roadway is curbed, any curb returns of the driveway shall match the existing curb line.

No portable curb channelization shall be permitted on the entrance facility. Curbing for channelization should be constructed using a mountable-type curbing. Curbing can either be cast in place using forms or can be slip formed. Curbing placed on existing pavement shall be secured to the pavement surface by use of dowels, form pins, rebars, or other suitable means and must be approved by DelDOT. Special details must be included in the construction plans. Channelization may be poured monolithically.

In rural areas curbing may be omitted if access can be effectively controlled by an existing roadside ditch or other means as determined by DelDOT.

Curbs being used on roadways with a posted speed of 50 mph or greater shall be limited to a 4 inch vertical face.

5.5.3 DITCHES AND SIDESLOPES

1. Subdivision Streets – The ditch and sideslope sections for subdivision streets shall meet the minimum slopes as shown on Figures 5-23 through 5-25.

   The minimum depth of a ditch has been established to provide for sub-surface drainage. This minimum depth must be

maintained throughout the subdivision. This depth can vary if a swale over a closed drainage system is used.

To minimize rutting and erosion of the roadside due to on-street parking, the site plan shall be developed to allow for three vehicles to be stored in the driveway beyond the right-of-way.

On streets without curbs, a six-foot grass shoulder shall be treated with an approved turf reinforcement mat to protect the edge of the pavement and to minimize the potential for soil erosion. In addition, design stormwater velocities within the open ditch section shall be limited to a maximum of five feet per second.

2. State-Maintained Roadways – DelDOT's *Road Design Manual* and AASHTO's Roadside Design Guide shall be used when designing sideslopes and ditch sections associated with any entrance improvements.

   If pipes are used at site entrances in conjunction with an open drainage system, the longitudinal slope from the entrance pavement to the top of the pipe shall be six-to-one (6:1).

5.5.4 UNDERDRAINS

The long-term presence of water within the pavement structure is largely responsible, directly and indirectly, for many of the distress and performance problems in pavement systems. The addition of longitudinal perforated underdrains is a feasible and cost-effective option. Underdrains are a system of perforated pipes that collect and transmit the water to an outfall site.

Underdrains shall be installed on all subdivision streets. The typical section shall show the location of the underdrain in accordance with Figures 5-23 through 5-25. Refer to DelDOT's *Standard Construction Details* for dimensions and materials.

If the developer can, through an engineering analysis, signed and sealed by a Professional Engineer registered in Delaware, prove underdrains are not warranted, DelDOT shall grant a waiver on the required underdrains referenced above. All costs associated with the developer's engineering analysis shall be at their cost. DelDOT will not provide any reimbursement.

The engineering analysis shall include the following:

1. Average water table for the last 25 years for the area in question.
2. Soil boring information including characteristics and AASHTO classification.
3. Infiltration rate (tested in accordance with ASTM D5126-90 "Comparison of Field Methods for Determining Hydraulic Conductivity in the Vadose Zone").
4. Topography maps for the area in question,
5. USGS wetland delineation maps.

Upon submission of all the information listed above, DelDOT will review the analysis and provide a written response to the developer's request for non-utilization of underdrains.

5.5.5 CLEAR ZONE

The clear zone is defined in AASHTO's Roadside Design Guide as "the total roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a non-recoverable slope, and/or a clear run-out area. The desired width is dependent upon the traffic volumes and speeds and on the roadside geometry."

Adequate lateral clearance between the edges of traffic lanes and roadside obstructions has been shown to be a very important safety factor. Vehicles leaving the roadway should have a reasonable opportunity to recover control and return to the roadway without overturning or colliding with roadside obstacles such as trees, poles, headwalls, or other large objects. The

combination of a relatively flat slope and an obstacle-free roadside within the prescribed clear zone helps this situation.

The determination of a clear zone is a function of speed, volume, curvature, and embankment slope. The current edition of AASHTO's Roadside Design Guide should be used for determining clear zone widths. For entrances onto rural collectors and rural local roads, a minimum clear zone width of ten feet from the edge of travel lane shall be provided. For subdivision streets, a minimum clear zone of three feet measured from the back of curb shall be provided.

Some roadside appurtenances, such as guardrails, breakaway light poles and signs using breakaway posts, may be part of a proposed development. If they are located within the specified clear zone they must be crashworthy in accordance with NCHRP Report 350 Test Level III Criteria. They should also be placed in the safest available location, minimizing their use when possible.

For guardrails within the clear zone, it is desirable to maintain a minimum two-foot lateral clearance between the outer edge of the usable shoulder and the face of the rail. Guardrails in and of themselves present a hazard and only should be used as a last resort if objects can not be moved or the required sideslopes can not be provided. At bridge approaches, guardrails should either match the width of the bridge or taper to meet the bridge rail. Refer to DelDOT's *Standard Construction Details* for more information on guardrail types and end treatments.

Figure 5-23 Subdivision Street Typical Section (With Curb)
(Not to Scale)

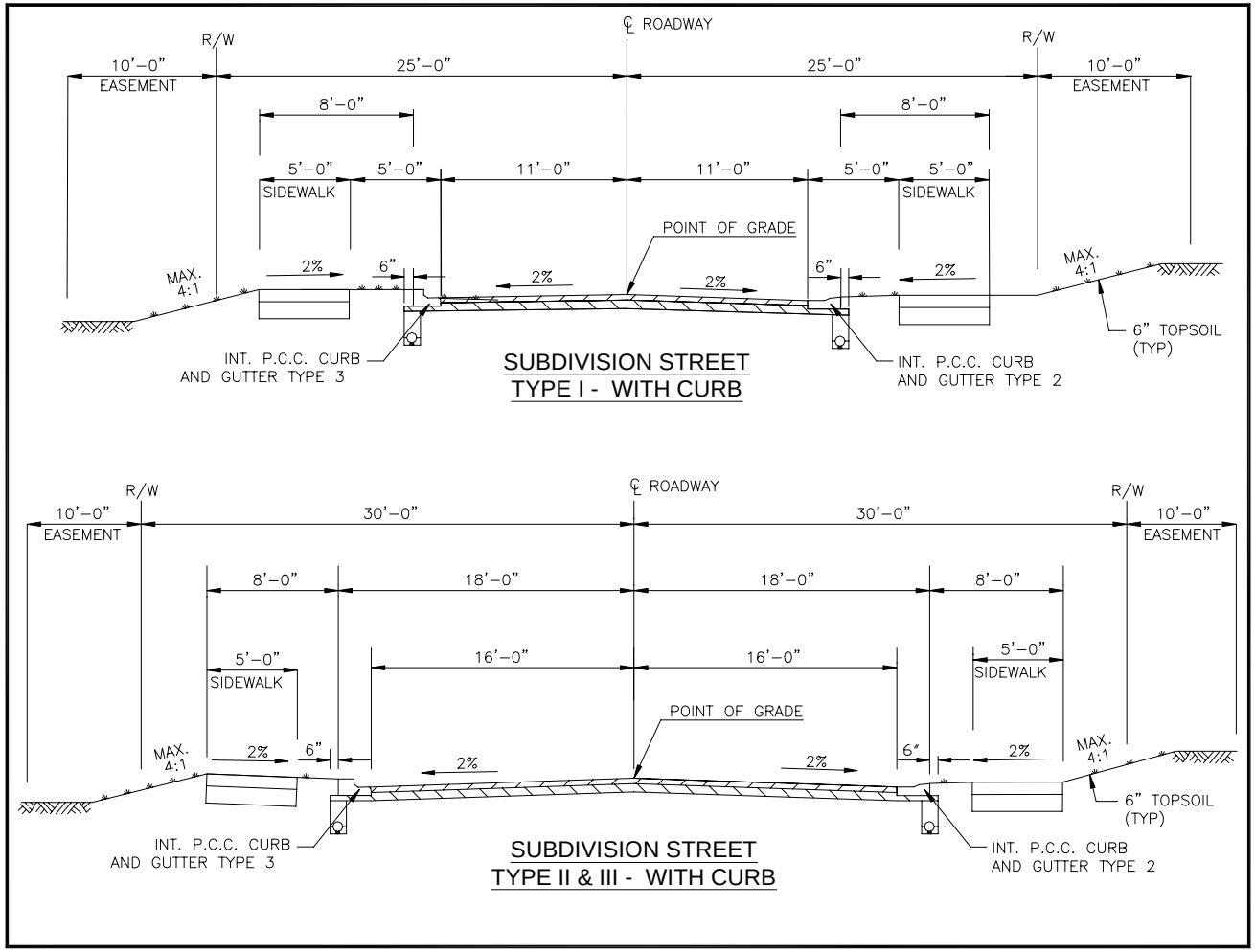


Figure 5-24 Subdivision Street Typical Section (Without Curb)
(Not to Scale)

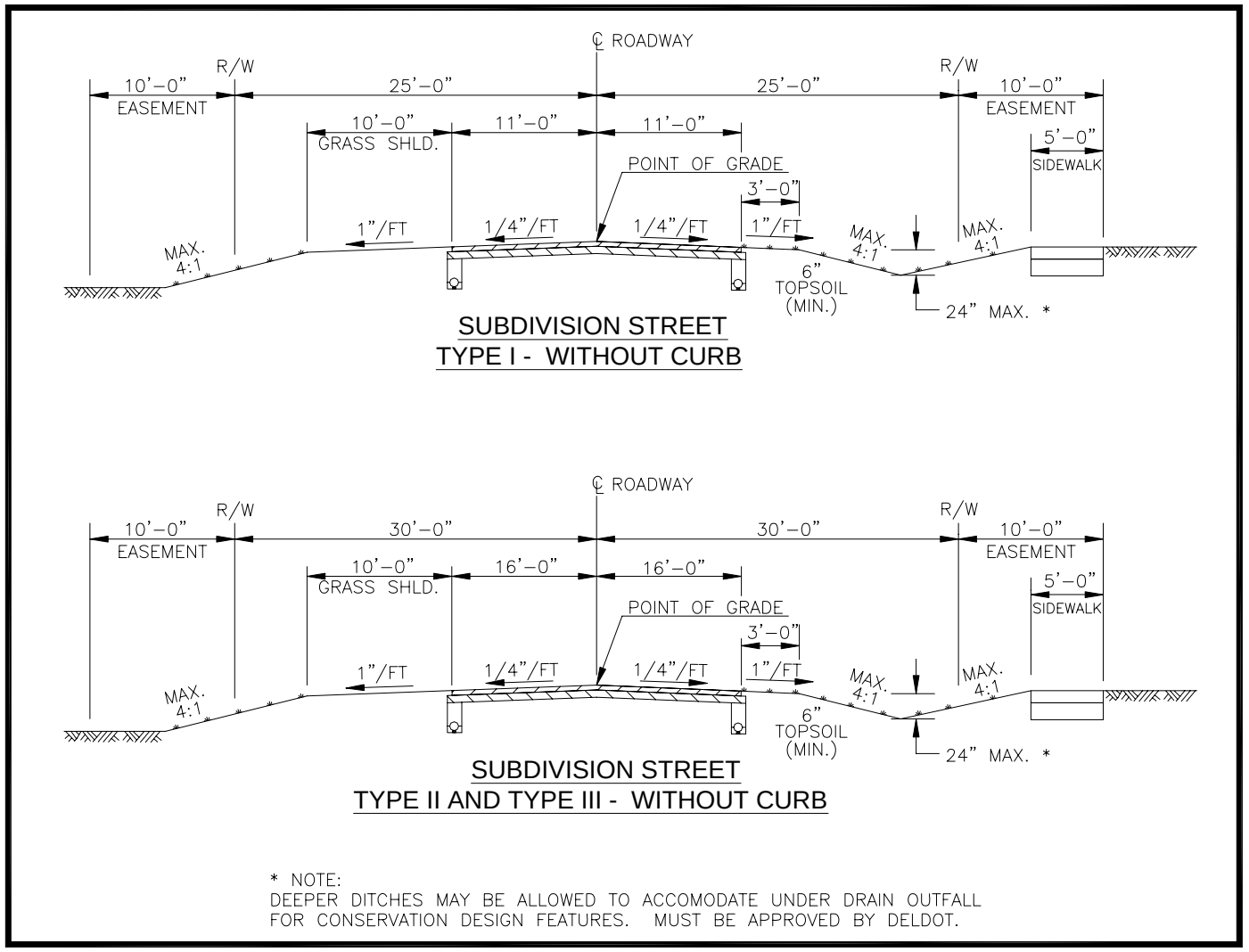
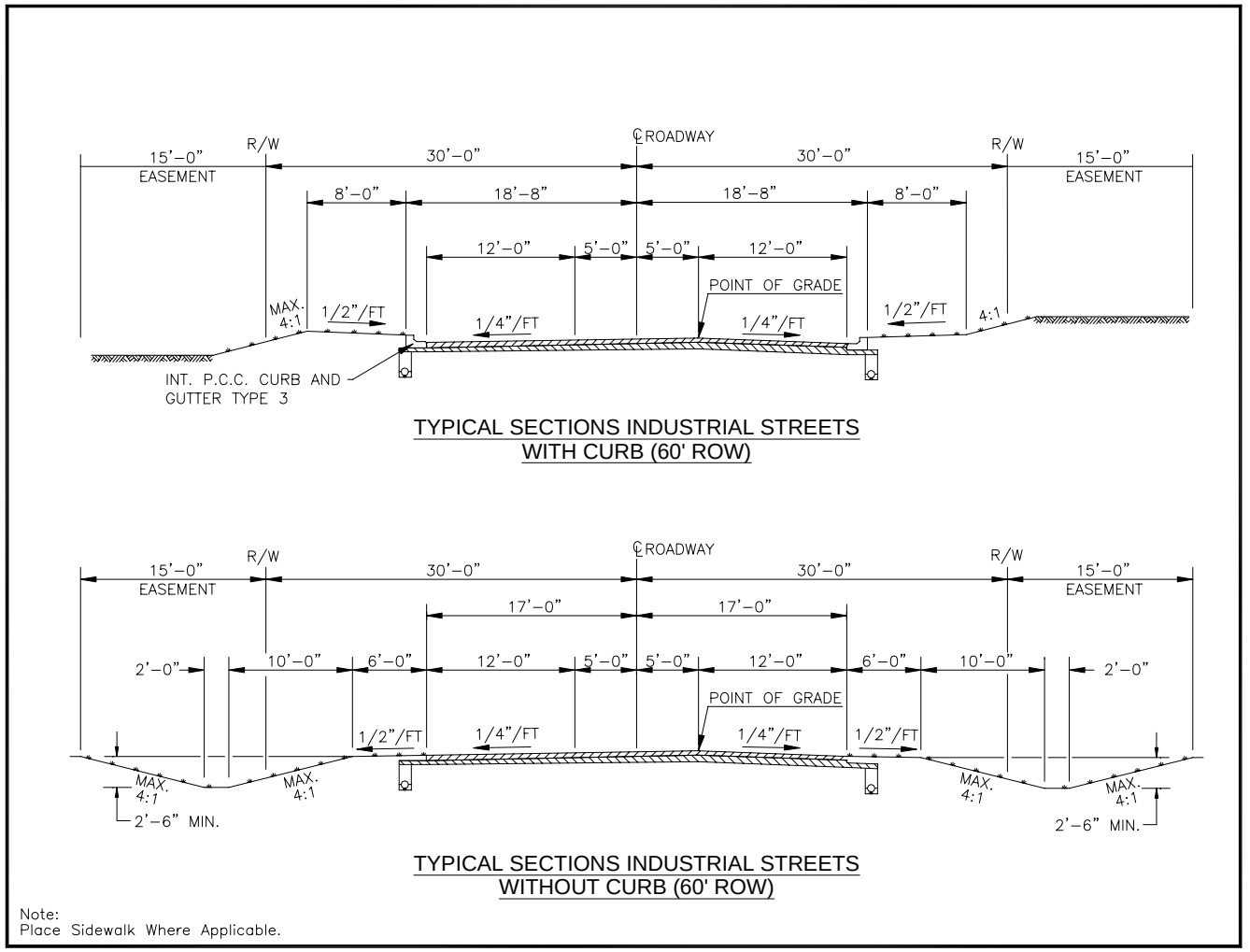


Figure 5-25 Industrial Streets Typical Section (With and Without Curb)
(Not to Scale)



5.6 PAVEMENT SECTIONS

Pavement sections are to be designed based on the ADT utilizing the planned roadway and the existing subsurface conditions. Acceptable pavement sections have been provided in Figure 5-22 and 5-23. If there is a concern with existing soil conditions DelDOT may perform subsurface investigations, at no cost to the developer, to determine subsurface conditions and if undercutting may be required prior to pavement box construction. This request shall be made prior to preliminary plan submission. The pavement sections listed in Figure 5-27 and 5-28 are designed to meet the required Structural Numbers (SN) and meet the following four conditions/criteria:

1. At least three and one-half inches of hot-mix asphalt pavement must be placed;
2. At least eight inches of graded aggregate base course (GABC) must be placed;
3. Hot-mix asphalt may only be placed directly over GABC, never placed directly over select borrow or subgrade; and
4. Undisturbed sub-grade and / or select borrow cannot be counted in Structural Number calculations.

Materials placed for construction of roadways in subdivisions, entrances, and industrial roadways must not be constructed in lifts that violate DelDOT's minimum and maximum lift thickness. The allowable lift thickness and structural values for materials used are shown in Figure 5-26.

Figure 5-26 Material Properties

	Lift Thickness		SN Contribution New (old)
	Minimum	Maximum	
Hot-Mix Asphalt Type C	1 ¼"	2"	0.4 (0.35)
Hot-Mix Asphalt Type B	2 ¼"	3"	0.4 (0.35)
Bituminous Concrete Base Course (BCBC)	3"	6"	0.32 (0.29)
GABC	–	8"	0.14 (0.14)

5.6.1 SUBDIVISION STREETS

All subdivision streets and entrances shall be paved with a hot-mix asphalt or Portland cement concrete surface. Pavement sections for internal subdivision streets are to be built to serve the traffic generated from the development upon completion, including all construction related traffic of the development. Should additional phases be planned that will be connected to the portion of the development under construction, the pavement section for the street shall be such that it will support both the phase under construction and the future phases. Figure 5-27 shows examples of pavement sections acceptable for use on internal subdivision streets.

When calculating the structural number of a section, consider whether traffic has been on the layer. For example:

A subdivision has an ADT of 136. Figure 5-27 requires that the structural number at completion be 2.27, while the section in place prior to 80% completion of the development must have a structural value of 1.65. To determine the structural value of the overall section, it is assumed that the materials in place (B and GABC) prior to completion have lost some of their structural value. Therefore, the calculation to determine the structural capacity of the section uses a combination of the new and old SN contribution values and is:

$$SN_{total} = Thickness_C * SN_{C-New} + Thickness_B * SN_{B-Old} + Thickness_{GABC} * SN_{GABC-old}$$

$$SN_{Total} = 1.25*0.4 + 2.25*0.35 + 8*.14 = 2.41 > 2.27$$

The structural number meets the requirements structurally for the overall value and meets the four conditions set forth in the beginning of this section. Once it is established that these are sufficient, the section must be verified to meet the required structural value. This calculation uses all new SN contribution values and is as follows:

$$SN_{80\%} = Thickness_B * SN_{B-New} + Thickness_{GABC} * SN_{GABC-New}$$

$$SN_{80\%} = 2.25*0.4 + 8*.14 = 1.90 > 1.65$$

This calculation shows how the required section is calculated and may be used to adjust thickness requirements of example sections as long as all requirements are met and lift thickness values are not violated.

Figure 5-27 Pavement Design Chart for Internal Subdivision Streets

ADT	Required Structural Number – Overall (prior to 80% completion)	Pavement Section
1 – 150	2.27 (1.65)	1 ¼" Type C 2 ¼" Type B 8" GABC
151 – 500	2.78 (2.05)	1 ½ " Type C 3" Type B 8" GABC
501 – 1000	3.12 (2.32)	2" Type C 3" Type B 10" GABC (two equal lifts)
1001 – 2000	3.49 (2.63)	2" Type C 3" Type B 12" GABC (two equal lifts)
2001 – 3000	3.73 (2.84)	2" Type C 3" Type B 14" GABC (two equal lifts)
3001 – 5000	4.05 (3.13)	1 ¼" Type C 2 ¼" Type B 6" BCBC 8" GABC
> 5000	Submit data to DelDOT for Pavement design	

5.6.2 ENTRANCES

Pavement sections for entrances on State-maintained roadways are to be designed using the average daily traffic using that entrance or 20% of the mainline traffic, whichever is greater (see Figure 5-28). Other sections to be constructed in conjunction with the entrance to the highway that must be submitted for design by DelDOT are:

- Right-turn lanes.
- Bypass lanes.
- Left-turn lanes.
- Entrances that do not conform to the description listed in Figure 5-28 for each class.
- Class E entrances.

Figure 5-28 Pavement Design Chart for Entrances

CLASS	Required Structural Number	Pavement Section
Class A • Traffic Volume less than 50 ADT • No Trucks	2.40	1 ¼" Type C 2 ¼" Type B 8" GABC
Class B • Traffic Volume 51 to 500 ADT • No trucks	2.78	1 ¼" Type C 3" Type B 8" GABC
Class C • Traffic Volume 501 to 2000 ADT • Less than 15 light duty trucks per day	3.49	2" Type C 3" Type B 11" GABC (two equal lifts)
Class D • Traffic Volume 2001 to 5000 ADT • Less than 50 light duty trucks per day	4.05	1 ¼" Type C 2 ¼" Type B 5" BCBC 8" GABC
Class E • Traffic volume > 5000 ADT • Over 50 trucks per day	Submit data to DelDOT for Pavement design	

5.6.3 INDUSTRIAL STREETS / ENTRANCES

Streets that are to be used as entrances to industrial parks must be built to State requirements. DelDOT must perform all designs for proposed industrial streets, because no industrial street is anticipated to carry similar loadings.

5.7 DRAINAGE DESIGN

5.7.1 GENERAL

Surface runoff water is a serious threat to both the physical integrity and the serviceability of roadway facilities. Runoff water must be adequately controlled so that it may pass through and be removed from the roadway area without damaging the roadway or adjacent properties.

As part of the overall design, the developer's engineer shall provide adequate drainage of the roadway and the site in accordance with all applicable standards. DelDOT has jurisdiction over drainage and any drainage system that impacts the State right-of-way.

A drainage report shall be submitted with the construction plans to verify pipe sizing, Hydraulic Grade Line (HGL), pipe cover, velocities, stabilization and water spread on the roadway.

5.7.2 DRAINAGE CRITERIA

Drainage criteria for different drainage installations are discussed below and summarized in Figure 5-30.

5.7.2.1 Culverts

A culvert is a drainage structure which transports water from a natural drainage course.

Based on the peak flow and watershed area, an appropriate tool for determining runoff shall be determined. The following criteria shall be used for culverts:

- A 25-year storm frequency shall be used.
- The headwater elevation shall be one foot below the edge of the proposed shoulder. The resulting ponding shall not negatively impact the highway or the adjacent property.
- The minimum pipe size shall be 18 inches in diameter.

See Hydraulic Design Series Number 5 (HDS 5), *Hydraulic Design of Highway Culverts*, September 2001, USDOT, FHWA.

5.7.2.2 Storm Sewers

The following criteria shall be used for storm sewers:

- A 10-year storm frequency shall be used.
- For sump conditions a 25-year storm frequency shall be used.
- The hydraulic gradient shall be no higher than one foot below the top of the grate for ten-year storms and just below the top of the grate for 25-year storms.

The following criteria shall be used in calculating HGL:

- Tail water elevation of the outfall, if it is higher than the normal crown of the outfall pipe.

  OR
- Normal crown of the outfall pipe. For dry ponds, the pipe invert elevation shall be equal to the bottom of pond elevation. For wet ponds, the pipe invert elevation shall be equal to or higher than the normal pool elevation of the pond.
- For a storm drain system discharging into a stream, the invert of the discharging pipe shall be no lower than the level of the base flow. If the stream is dry most of the time, the invert shall be at least a foot above the stream bottom. The HGL shall start from the crown of the pipe.

If the Natural Resources Conservation Service (NRCS) method is used in calculating the HGL, the engineer shall specify in the report or on the plans which criterion was used to determine the HGL elevations.

See *Design of Urban Highway Drainage - The State of the Art*, August 1979, USDOT, FHWA for additional information on storm sewer design.

Culverts and storm sewers can be made from Reinforced Concrete Pipe (RCP), Metal Pipe (MP) or High Density Polyethylene (HDPE). The use of these material types is outlined in Figure 5-29.

5.7.2.3 Inlet Design

Inlet design for entrances shall be in accordance with DelDOT's *Road Design Manual*. The following criteria shall be used for inlets within subdivision streets:

- A 10-year storm frequency.
- The spread of water shall be no greater than half the width of the adjacent travel lane.
- Maximum spacing of inlets is 300 feet.

5.7.2.4 Parallel Ditching

The following criteria shall be used for parallel ditching:

- A 5-year storm frequency.
- The depth of the water in the ditch shall not be higher than six inches below the edge of the proposed shoulder.

Figure 5-29 Material Usage for Culverts and Storm Sewers

	RCP			HDPE**	MP**
	Class III	Class IV	Class V***		
Embankment Height*	> (1) foot	6 inches to 1 foot	< 6 inches	• 1 foot on local roads. • 2 feet on collectors & arterials.	• 1 foot on local roads. • 2 feet on collectors & arterials.

* *From top of pipe to the bottom of flexible pavement.*
** *The use of MP and HDPE must be approved by DelDOT.*
*** *The use of Class V pipe must be approved by DelDOT.*

5.7.2.5 Drainage Easements

Drainage easements are required for all drainage facilities handling subdivision street runoff which are not located within a dedicated right-of-way. Underground drainage facilities shall require a 20-foot drainage easement. The pipe must be located in the center of the easement. Open drainage facilities shall require a width equal to the width of the facility at the proposed ground level plus a 10-foot easement on one side and a minimum of a five-foot easement on the other side of the open drainage facility.

5.7.2.6 Offsite Easements

Drainage easements are required for offsite drainage facilities in order to provide positive drainage from the development to the point of discharge. Development drainage must be carried to a natural or existing drainage course. Copies of drainage easements are to be provided to DelDOT and referenced on the record plan.

5.7.2.7 Drainage Discharge

The outfall shall be carried to a point of positive outfall in order to prevent downstream

flooding. A detailed hydraulic and stormwater analysis downstream any distance as deemed necessary shall be required to determine the impacts to the drainage system and to ensure that stormwater impacts for surrounding property owners is minimized.

5.7.2.8 Drainage Design Report

A drainage design report containing the following minimum data shall be prepared for each project.

a. Drainage area plan.
b. Time of concentration.
c. Weighted runoff coefficient.
d. Design discharge.
e. Type and slope of drainage facility.
f. Spacing of drainage inlets.
g. Erosion protection methods – riprap sizing calculations.
h. Inlet spread calculations.
i. Culverts – headwater elevations.
j. Hydraulic Grade Line (HGL) calculations.
k. Full flow pipe velocity.
l. Actual flow pipe velocity.
m. Difference between inlet grate elevation and HGL elevation.

See Figures 5-37 through 5-42 for various drainage charts that are to be used in the preparation of the drainage report.

Figure 5-30 Drainage Criteria

Type	Design Frequency		Minimum Flow Full Velocity (ft/sec)	Maximum Allowable Velocity (ft/sec)	Free Board from Edge of Roadway
	Normal	Sag			
Culvert	25	25	2	–	1 foot
Storm Sewer	10	25	2	8	1 foot
Roadside Ditch	10	10	–	3	6 inches
Inlets	10	10	2	8	–

Figure 5-31 Angle of Deflection for Circular Reinforced Concrete Pipes Entering and Exiting Inlet Boxes

Inlet Size	Pipe Sizes (Including Wall Thickness)												
	12" (16")	15" (19.5")	18" (23")	21" (26.5")	24" (30")	27" (33.5")	30" (37")	33" (40.5")	36" (44")	42" (51")	48" (58")	54" (65")	60" (72")
34" x 18"	47.16°	39.09°	29.95°	18.67°	0.00°								
34" x 24"	47.16°	39.09°	29.95°	18.67°	0.00°								
48" x 30"	61.12°	56.19°	51.04°	45.60°	39.74°	33.26°	25.81°	16.45°	0.00°				
48" x 48"	61.12°	56.19°	51.04°	45.60°	39.74°	33.26°	25.81°	16.45°	0.00°				
66" x 30"	69.59°	66.23°	62.80°	59.29°	55.68°	51.94°	48.03°	43.92°	39.53°	29.51°	15.86°		
66" x 48"	69.59°	66.23°	62.80°	59.29°	55.68°	51.94°	48.03°	43.92°	39.53°	29.51°	15.86°		
66" x 66"	69.59°	66.23°	62.80°	59.29°	55.68°	51.94°	48.03°	43.92°	39.53°	29.51°	15.86°		
72" x 24"	71.40°	68.36°	65.27°	62.12°	58.89°	55.57°	52.14°	48.57°	44.83°	36.62°	26.78°	12.75°	
72" x 48"	71.40°	68.36°	65.27°	62.12°	58.89°	55.57°	52.14°	48.57°	44.83°	36.62°	26.78°	12.75°	
72" x 72"	71.40°	68.36°	65.27°	62.12°	58.89°	55.57°	52.14°	48.57°	44.83°	36.62°	26.78°	12.75°	
34" x ***18"***													
34" x ***24"***	23.28°	4.25°											
48" x ***30"***	40.16°	30.05°	17.47°										
48" x ***48"***	61.12°	56.19°	51.04°	45.60°	39.74°	33.26°	25.81°	16.45°	0.00°				
66" x ***30"***	40.16°	30.05°	17.47°										
66" x ***48"***	61.12°	56.19°	51.04°	45.60°	39.74°	33.26°	25.81°	16.45°	0.00°				
66" x ***66"***	69.59°	66.23°	62.80°	59.29°	55.68°	51.94°	48.03°	43.92°	39.53°	29.51°	15.86°		
72" x ***24"***	23.28°	4.25°											
72" x ***48"***	61.12°	56.19°	51.04°	45.60°	39.74°	33.26°	25.81°	16.45°	0.00°				
72" x ***72"***	71.40°	68.36°	65.27°	62.12°	58.89°	55.57°	52.14°	48.57°	44.83°	36.62°	26.78°	12.75°	

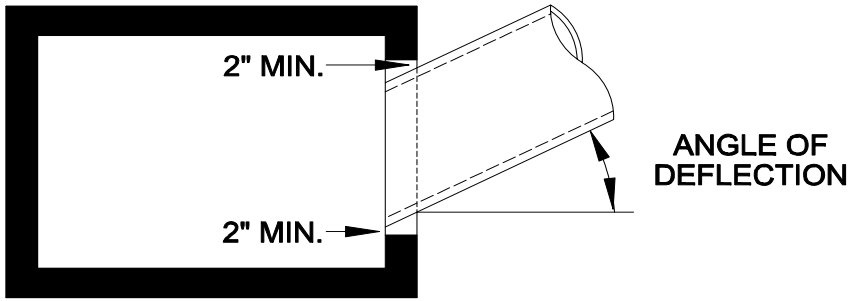


Figure 5-32 Angle of Deflection of Horizontal Elliptical Concrete Pipes Entering and Exiting Inlet Boxes

Inlet Size	Pipe Sizes (Including Wall Thickness)								
	14" x 23" (19 1/2" x 28 1/2")	19" x 30" (25 1/2" x 36 1/2")	22" x 34" (29" x 41")	24" x 38" (31 1/2" x 45 1/2")	27" x 42" (34 1/2" x 49 1/2")	29" x 45" (38" x 54")	32" x 49" (41 1/2" x 58 1/2")	34" x 53" (44" x 63")	38" x 60" (49" x 71")
RCP Equiv.	18"	24"	27"	30"	33"	36"	39"	42"	48"
34" x 18"	10.01°								
34" x 24"	10.01°								
48" x 30"	42.31°	26.96°	14.83°						
48" x 48"	42.31°	26.96°	14.83°						
66" x 30"	57.24°	48.60°	43.31°	37.55°	31.84°	24.37°	14.56°		
66" x 48"	57.24°	48.60°	43.31°	37.55°	31.84°	24.37°	14.56°		
66" x 66"	57.24°	48.60°	43.31°	37.55°	31.84°	24.37°	14.56°		
72" x 24"	60.28°	52.63°	48.04°	43.16°	38.48°	32.67°	25.98°	5.46°	
72" x 48"	60.28°	52.63°	48.04°	43.16°	38.48°	32.67°	25.98°	5.46°	
72" x 72"	60.28°	52.63°	48.04°	43.16°	38.48°	32.67°	25.98°	5.46°	
34" x ***18"***									
34" x ***24"***									
48" x ***30"***									
48" x ***48"***	42.31°	26.96°	14.83°						
66" x ***30"***									
66" x ***48"***	42.31°	26.96°	14.83°						
66" x ***66"***	57.24°	48.60°	43.31°	37.55°	31.84°	24.37°	14.56°		
72" x ***24"***									
72" x ***48"***	42.31°	26.96°	14.83°						
72" x ***72"***	60.28°	52.63°	48.04°	43.16°	38.48°	32.67°	25.98°	5.46°	

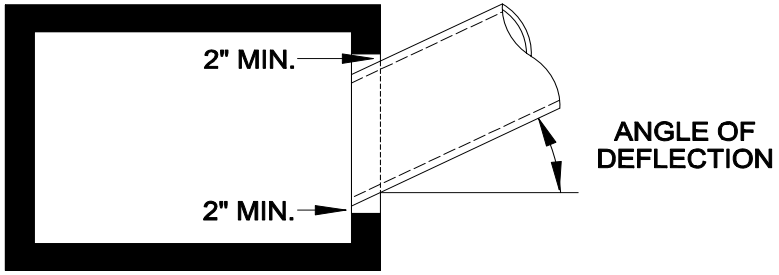
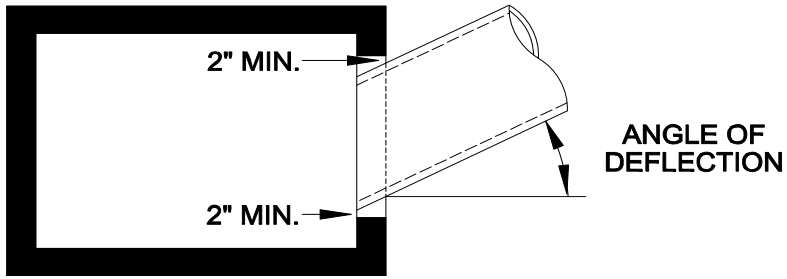


Figure 5-33 Angle of Deflection of Arched Concrete Pipes Entering and Exiting Inlet Boxes

Inlet Size	Pipe Sizes (Including Wall Thickness)							
	11" x 18"	13 1/2" x 22"	15 1/2" x 26"	18" x 28.5"	22.5" x 36.25"	26 5/8" x 43 3/4"	31 5/16" x 51 1/8"	36" x 58 1/2"
	(15 1/2" x 22 1/2")	(18 1/2" x 27 1/2")	(21" x 31 1/2")	(24" x 34 1/2")	(29 1/2" x 43 1/4")	(34 5/8" x 51 3/4")	(40 5/16" x 60 1/8")	(46" x 68 1/2")
RCP Equiv.	15"	18"	21"	24"	30"	36"	42"	48"
34" x 18"	31.35°	14.68°						
34" x 24"	31.35°	14.68°						
48" x 30"	51.79°	43.97°	37.05°	31.26°	5.34°			
48" x 48"	51.79°	43.97°	37.05°	31.26°	5.34°			
66" x 30"	63.30°	58.27°	54.09°	50.84°	40.50°	28.29°		
66" x 48"	63.30°	58.27°	54.09°	50.84°	40.50°	28.29°	9.62°	
66" x 66"	63.30°	58.27°	54.09°	50.84°	40.50°	28.29°	9.62°	
72" x 24"	65.72°	61.20°	57.48°	54.60°	45.64°	35.66°	23.22°	
72" x 48"	65.72°	61.20°	57.48°	54.60°	45.64°	35.66°	23.22°	
72" x 72"	65.72°	61.20°	57.48°	54.60°	45.64°	35.66°	23.22°	
34" x ***18"***								
34" x ***24"***								
48" x ***30"***	19.52°							
48" x ***48"***	51.79°	43.97°	37.05°	31.26°	5.34°			
66" x ***30"***	19.52°							
66" x ***48"***	51.79°	43.97°	37.05°	31.26°	5.34°			
66" x ***66"***	63.30°	58.27°	54.09°	50.84°	40.50°	28.29°	9.62°	
72" x ***24"***								
72" x ***48"***	51.79°	43.97°	37.05°	31.26°	5.34°			
72" x ***72"***	65.72°	61.20°	57.48°	54.60°	45.64°	35.66°	23.22°	



5.7.3 PERSONNEL GRATE FOR PIPE INLET

Personnel grates shall be installed on pipe inlets to improve safety by preventing people, animals and debris from entering stormwater pipes 12 inches and larger with open inlets (i.e., without a grate or drainage inlet) for which full daylight is not visible when looking through the pipe to the other end.

5.7.3.1 Design Guidance

Since safety grates become blocked by debris, thus potentially decreasing drainage flow and increasing maintenance needs, engineers shall evaluate designs to avoid open inlets to stormwater pipes. One alternative to consider is creating a separation of pipe runs by realigning pipes in a long pipe run into relatively short, straight runs, with daylight visible from the openings.

A personnel grate for a pipe inlet shall be considered as the last resort in designing inlets for storm drain systems. Grates shall be secured to prevent entry by the public but allow access to the storm drainpipe for maintenance and repair.

Construction details and specifications shall be included in the construction plans.

5.7.4 HYDROLOGY

The Rational Method of estimating the storm runoff shall be utilized for all subdivision streets and waterway openings equal to or less than 19 square feet. The proposed method for computing the storm runoff requiring a waterway opening greater than 19 square feet shall be approved by DelDOT. The Rational Method of design is as follows:

$$Q = C\,i\,A$$

Where,

Q = Rate of runoff in cubic feet per second.

C = Weighted runoff coefficient (average of the coefficients assigned to the different types of contributing areas).

i = Average rainfall intensity, inches per hour, for the selected frequency and for duration equal to the time of concentration.

A = drainage area, in acres, tributary to the point under design.

Values of runoff coefficient (C) for various types of contributing areas indicated in Figure 5-34 shall be utilized in the solution of this method of design.

Figure 5-34 Runoff Coefficient (C) for Use in Rational Method

Type of surface	Runoff coefficient (C)
Rural areas	0.15-0.3
Concrete or sheet asphalt pavement	0.8-0.9
Asphalt macadam pavement	0.6-0.8
Gravel roadways or shoulders	0.4-0.6
Bare earth	0.2-0.9
Steep grassed areas (2:1)	0.5-0.7
Turf meadows	0.1-0.4
Forested areas	0.1-0.3
Cultivated fields	0.2-0.4

For flat slopes or permeable soil, use the lower values. For steep slopes or impermeable soil, use the higher values.

Contributing drainage areas shall be evaluated based on the fully developed land in accordance with the existing or proposed zoning.

Figure 5-35 Runoff Coefficient (C) for Different Type of Surface

Type of surface	Runoff coefficient (C)
Flat residential, with about 30% of area impervious	0.40
Flat residential, with about 60% of area impervious	0.55
Moderately steep residential, with about 50% of area impervious	0.65
Moderately steep built up area, with about 70% of area impervious	0.80
Flat commercial, with about 90% of area impervious	0.80

For a more detailed explanation of the Rational Method of design see "Design of Roadside Drainage Channels," published by USDOT, FHWA.

5.7.5 HYDRAULICS

Manning's Equation shall be utilized to express the flow of water in open channels. Manning's Equation is as follows:

$$V = \frac{1.40}{n} R^{2/3} S^{1/2}$$

Where:

V = Velocity in feet per second

n = Manning's coefficient of channel roughness

R = Hydraulic radius, in feet

S = Slope, in feet per foot

Values of Manning's coefficients (*n*) for various types of channel linings as indicated in Figure 5-36 shall be used.

For additional values see "Design Charts for Open-Channel Flow," published by USDOT, FHWA.

Figure 5-36 Manning's Roughness Coefficients (n)

Closed Conduits	
Reinforced Concrete Pipe (RCP)	0.012
Corrugated Metal Pipe (CMP) or Pipe Arch Plain or Fully Coated (Unpaved)	0.024
High Density Polyethylene (HDPE)	0.011
25% of circumference paved	0.021
Fully paved	0.012
Lined Open Channels	
Concrete (float finish)	0.014
Plain riprap	0.040
Grouted riprap	0.035
Swales and Channels with Maintained Vegetation	
Grass (mowed to 2")	0.045
Grass (good stand - 12" height)	0.09
Street Gutters	
Concrete	0.012
Asphalt	0.013

5.7.6 SUMP PUMP DISCHARGES

Sump pump discharges into roadside drainage systems shall be approved in writing by the DelDOT subdivisions inspector prior to installation. Prior to request for approval to discharge sump pump effluent into a roadside drainage system, the developer must provide written justification that there is no other feasible alternative. The developer must prove that the discharge cannot be routed to another outlet that is not within State right-of-way, and

the drainage cannot be contained within the parcel boundaries of the discharge source. This justification shall be approved (in writing) by the Conservation District.

If there is no alternative drainage outlet for the sump pump discharge other than the roadside drainage system (State right-of-way), then DelDOT may allow a connection within State right-of-way.

If there is an existing ditch in front of the property, then the sump pump outlet pipe may discharge into the ditch.

If there is an existing drainage inlet and closed drainage system in front of the property, then the Developer may connect the sump pump outlet discharge pipe directly into the drainage inlet. The hole in the basin must be core drilled (not jack-hammered). After installing the discharge pipe, the hole must be sealed with non-shrink grout to prevent leakage. The connection must be at least 12 inches from any pipe joints.

If there is a closed drainage system in front of the property, but no drainage inlet or ditch line exists, then a direct connection of the sump pump discharge pipe to the existing roadside drainage pipe within State right-of-way will be permitted. The tie-in must be made in the upper half of the pipe. The hole in the pipe must be core drilled (not jack hammered). After connecting the discharge pipe, the hole must be sealed with non-shrink grout to prevent leakage. The connection must be at least 12 inches from any pipe joints.

If there is an existing curb and gutter with no enclosed drainage or ditch in front of the property, then sump pump discharge into State right-of-way may be permitted. However, the sump pump discharge outlet pipe must be terminated at the State right-of-way line.

5.8 EROSION CONTROL

DelDOT will work cooperatively with regulating agencies to ensure proper erosion control. These agencies include Delaware Department of Natural Resources and Environmental Control (DNREC), New Castle County Land Use Engineering, New Castle County Conservation District, Kent Conservation District (KCD), and Sussex Conservation District (SCD).

All developments shall require a written plan for erosion control measures both during and after construction following the requirements outlined in Delaware's Sediment and Stormwater Regulations. The erosion control measures shall be designed following the Delaware Erosion and Sediment Control Handbook (Delaware ESC Handbook) including, but not be limited to, inlet protection, silt fence, stabilized rock construction entrance, sediment traps, stone check dams, temporary and permanent seeding, and mulching as required to minimize erosion during earth moving operations.

In addition to the Delaware ESC Handbook, the Conservation Design For Stormwater Management Guidelines shall be used whenever possible in conjunction with the Erosion and Sediment Control Best Management Practices (BMPS) for all projects.

When the proposed roadway work is limited to the site and the entrance, the review of design and construction of stormwater management and erosion control facilities is performed by a non-DelDOT delegated agency for DSSR enforcement. In this case, the non-DelDOT delegated agency shall attest that the DSSR within DelDOT right-of-way have been met and shall be documented in a memo and forwarded to DelDOT's Stormwater Engineer for files.

If the proposed roadway work is not contiguous with the land development proposal, the review of design and construction of erosion control plans shall be performed by DelDOT for DSSR enforcement. DelDOT will sign the plans

upon determination of full compliance of the plans and reports with the requirements of DSSR indicating that the plans meet the requirements of State and Federal sediment and stormwater regulations. DelDOT shall require at least 30 calendar days to review the erosion control plans.

Plans for review shall be developed in half size (11"x17") and arranged similar to DelDOT plans for consistency and ease of review. Section 1 of ES_2M Design Guide contains a checklist which shall be completed and submitted with the plans along with a transmittal memo requesting the plans to be reviewed by DelDOT.

5.8.1 RIPRAP DESIGN

Ripraps are a section of rock protection placed at the outlet end of culverts, conduits and channels, to reduce the velocity and energy of water such that the flow will not erode the receiving downstream areas.

The design of rock outlet protection depends entirely on location. Pipe outlets at the top of cuts or on slopes steeper than 10%, can not be protected by rock aprons or riprap section due to reconcentration of flows and high velocities encountered after the flow leaves the apron.

For detailed design guidelines see the latest edition of DNREC's *Erosion and Sediment Control Handbook*.

5.9 STRUCTURE DESIGN

Any structure, including supports, erected over a depression or an obstruction, such as water, a highway or a railway, for carrying vehicular or pedestrian traffic or other moving loads that has an opening exceeding 20 square feet shall be reviewed by DelDOT's Bridge Design Section.

All structural designs shall be in accordance with *DelDOT's Bridge Design Manual* and *AASHTO's Load and Resistance Factor Design (LRFD) Bridge Design Specifications*.

If there are structural designs required on a plan and not included in the Standard Construction Details, shop drawings signed and sealed by a professional engineer shall be submitted for review and approval.

Figure 5-37 Rainfall Intensity Estimates and Depths – New Castle County, Delaware

Rainfall Intensity Estimates (in/hr) New Castle County, Delaware										
Frequency (yr)	Duration (min)									
	5	10	15	30	60 (1 hr)	120 (2 hr)	180 (3 hr)	360 (6 hr)	720 (12 hr)	1440 (24 hr)
2	4.97	3.97	3.33	2.30	1.44	0.87	0.62	0.38	0.23	0.13
5	5.83	4.67	3.94	2.80	1.79	1.08	0.78	0.48	0.29	0.17
10	6.42	5.13	4.33	3.13	2.04	1.24	0.89	0.55	0.34	0.20
25	7.13	5.68	4.80	3.55	2.37	1.45	1.05	0.66	0.41	0.25
50	7.60	6.05	5.10	3.84	2.60	1.61	1.18	0.74	0.47	0.29
100	8.06	6.40	5.40	4.13	2.85	1.77	1.30	0.83	0.53	0.34
200	8.44	6.69	5.63	4.38	3.07	1.93	1.43	0.92	0.60	0.39
500	8.88	7.02	5.89	4.69	3.36	2.14	1.60	1.05	0.70	0.46

Interpolation shall be used for intermediate durations.

Figure 5-38 Rainfall Intensity Estimates and Depths – Kent County, Delaware

Rainfall Intensity Estimates (in/hr) Kent County, Delaware										
Frequency (yr)	Duration (min)									
	5	10	15	30	60 (1 hr)	120 (2 hr)	180 (3 hr)	360 (6 hr)	720 (12 hr)	1440 (24 hr)
2	5.06	4.05	3.40	2.34	1.47	0.90	0.65	0.40	0.24	0.14
5	6.01	4.81	4.06	2.88	1.85	1.13	0.82	0.50	0.30	0.18
10	6.68	5.35	4.51	3.27	2.13	1.31	0.95	0.59	0.36	0.21
25	7.54	6.01	5.08	3.76	2.50	1.56	1.14	0.71	0.44	0.27
50	8.15	6.49	5.48	4.13	2.79	1.76	1.29	0.81	0.51	0.32
100	8.76	6.96	5.86	4.49	3.09	1.96	1.45	0.92	0.59	0.37
200	9.32	7.39	6.22	4.84	3.39	2.17	1.62	1.04	0.67	0.43
500	10.02	7.93	6.65	5.29	3.80	2.45	1.85	1.21	0.80	0.52

Interpolation shall be used for intermediate durations.

Figure 5-39 Rainfall Intensity Estimates and Depths – Sussex County, Delaware

Rainfall Intensity Estimates (in/hr) Sussex County, Delaware										
Frequency (yr)	Duration (min)									
	5	10	15	30	60 (1 hr)	120 (2 hr)	180 (3 hr)	360 (6 hr)	720 (12 hr)	1440 (24 hr)
2	5.06	4.04	3.39	2.34	1.47	0.91	0.66	0.40	0.24	0.14
5	6.02	4.83	4.07	2.89	1.85	1.16	0.84	0.52	0.30	0.19
10	6.76	5.40	4.56	3.30	2.15	1.35	0.99	0.61	0.36	0.22
25	7.67	6.11	5.16	3.82	2.54	1.61	1.19	0.74	0.45	0.28
50	8.32	6.62	5.59	4.21	2.85	1.83	1.35	0.85	0.52	0.33
100	8.96	7.12	6.00	4.59	3.16	2.05	1.53	0.97	0.61	0.38
200	9.60	7.61	6.40	4.98	3.49	2.28	1.71	1.10	0.70	0.45
500	10.38	8.21	6.88	5.48	3.93	2.59	1.97	1.28	0.84	0.54

Interpolation shall be used for intermediate durations.

Figure 5-40 Overland Flow Time

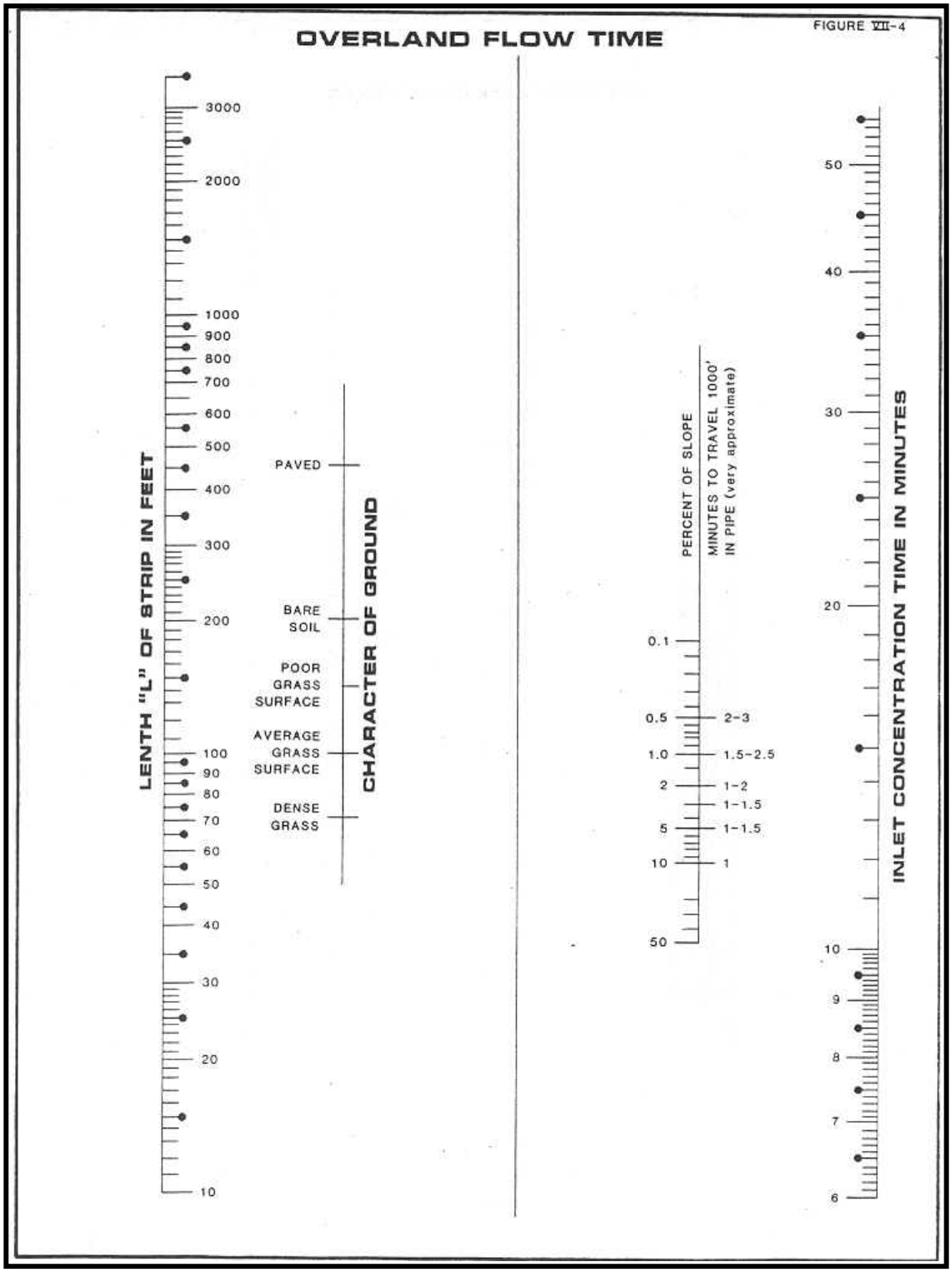


Figure 5-41 Street Flow Time

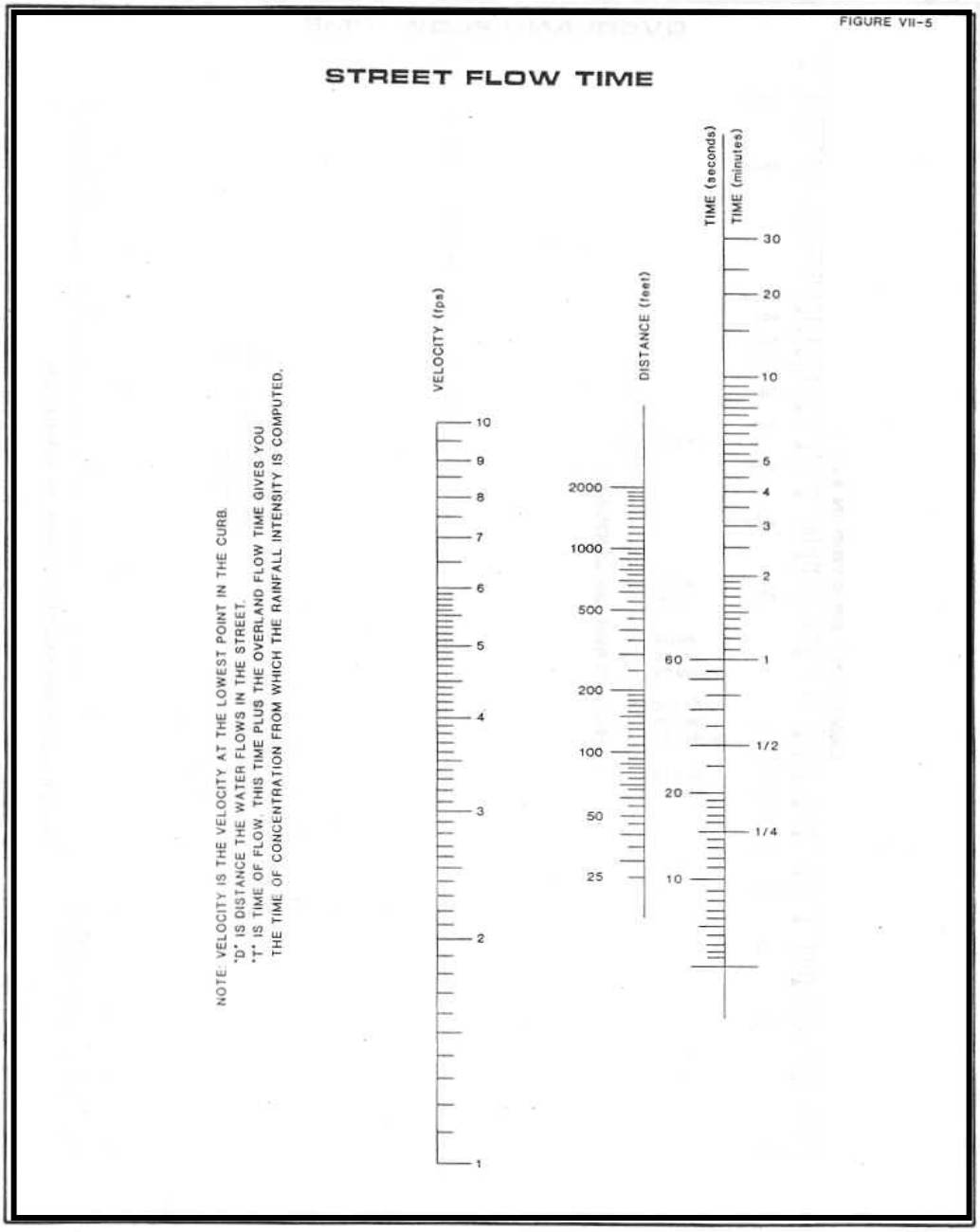
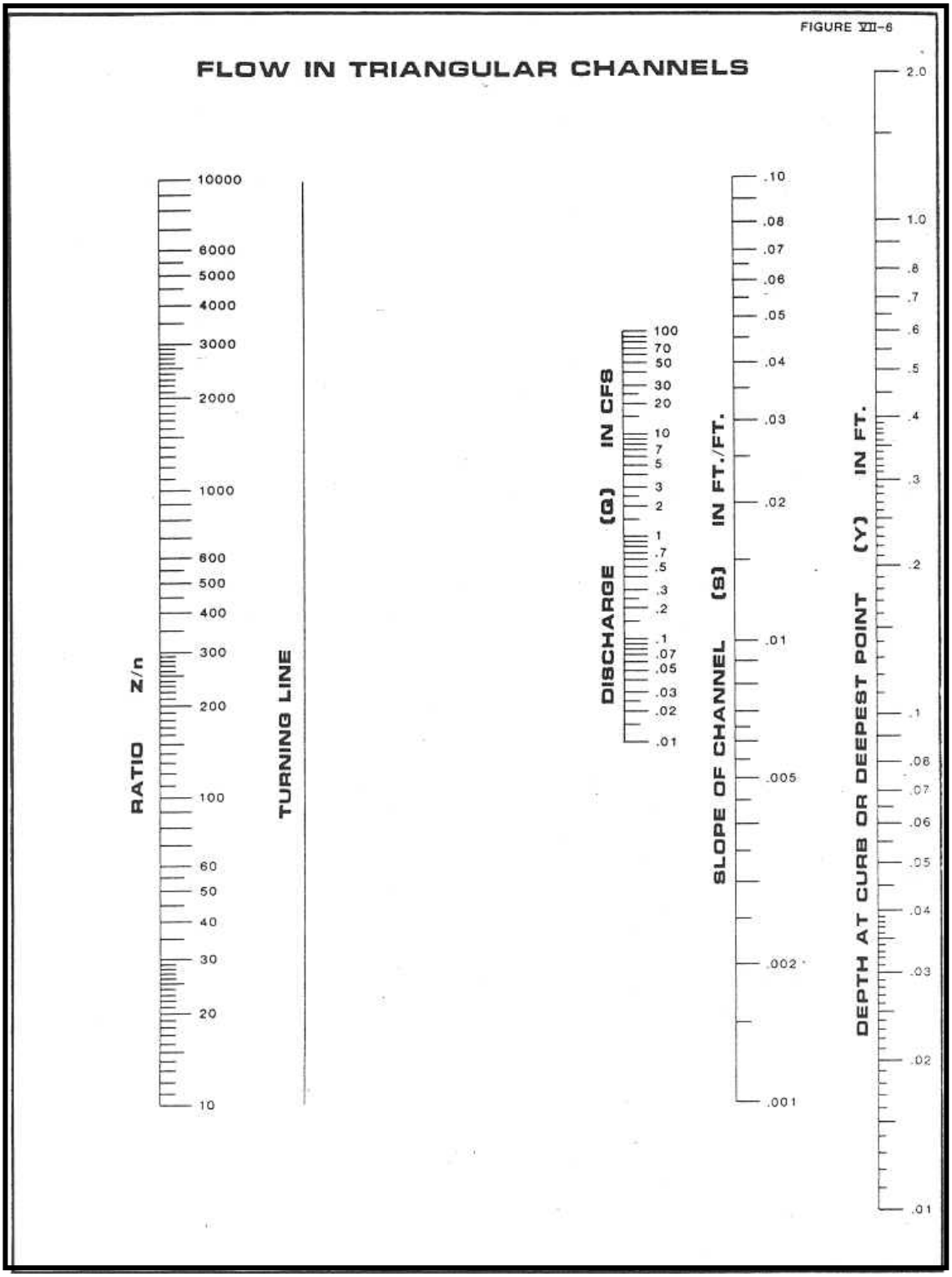


Figure 5-42 Flow in Triangular Channels



5.10 SIGNING AND PAVEMENT MARKING DESIGN

5.10.1 SIGNING

Traffic control signs shall be required for all commercial and subdivision entrances and streets. Traffic control signs shall be installed and maintained by the developer where required. The signs must be included on the construction plan in accordance with DelDOT requirements and the MUTCD. All advertising signs in conjunction with a business establishment shall be placed in conformance with the current Delaware Code relating to Outdoor Advertising.

5.10.1.1 Placement of Signs

Traffic signs shall be furnished and installed by the developer in accordance with a signing plan prepared by the developer's engineer and approved by DelDOT. Signs shall be installed in accordance with the MUTCD and Standard Sheet T-5. DelDOT shall provide direction regarding necessary signs and their placement on the signing plan at the time of semi-final construction plan review.

5.10.1.2 Specifications

All signs shall conform to Federal and State specifications applicable to size, color, reflectivity, and fabrication. In order to ensure uniformity, DelDOT shall fabricate signs upon request, provided that the developer bears all costs for the signs. However, developers are encouraged to seek private sources first. Additional information pertaining to the size, colors, and fabrication of signs may be obtained by contacting DelDOT's Sign Shop at the following address:

DelDOT Sign Shop
P.O. Box 778
Dover, DE 19903

5.10.1.3 Maintenance of Signs

The developer of a new subdivision or commercial property is required to purchase, install, and maintain all signs required by DelDOT. Once a development street or entrance is accepted for maintenance by the State, DelDOT shall assume maintenance for all the signs which were required for acceptance and are located within the right-of-way.

5.10.1.4 Signs Required in Suburban Development

1. Street Name Signs

   a. Placement – The location of street name signs shall be in accordance with Figure 5-43.

   b. Specifications – Street name signs shall be fabricated with four-inch letters Type III silver reflective sheeting on a background of six-inch Type II green reflective sheeting mounted on 6¾-inch aluminum sign extrusion, as specified on Standard Sheet T-4.

2. Development Name Signs

   a. Placement – The development name signs shall be installed within the right-of-way of the highway on which the entrance(s) is (are) located. The signs shall be placed within 500 feet of the centerline of the entrance(s). In order to adequately notify motorists of entrances to subdivisions, one set of development name signs can be authorized per major or minor roadway on which there is an entrance.

      The development name signs are not directional signs nor guide signs and the placement of these signs at adjacent intersections near the development or on State-maintained roads other than the road on which the entrance is located is prohibited.

   b. Specifications – All development name signs shall be fabricated on high intensity reflective sheeting mounted on 0.080"

(minimum) aluminum sheet. The signs shall have a silver legend and blue background with a yellow and blue Caesar Rodney image. See Figure 5-44 and 5-45 for details.

3. Regulatory and Warning Signs

   a. Placement – One "Speed Limit 25" / Pictorial "Watch Children" sign combination shall be installed at each entrance to a suburban development. Other signs shall be installed in accordance with DelDOT requirements.

   b. Specifications – All regulatory, warning, and other traffic control signs shall be fabricated from Type III reflective sheeting on 0.080" (minimum) aluminum sheet and shall conform to MUTCD requirements.

5.10.2 PAVEMENT MARKINGS

Pavement markings that are required as part of an entrance design shall be in accordance with current DE-MUTCD requirements. Type III subdivision streets shall have a centerline and edge line stripes.

If there is any conflict between this manual and the DE-MUTCD regarding the pavement marking and signing of any State maintained roadway, then the DE_MUTCD shall supersede any other existing guideline.

Figure 5-43 Street Name Sign Location

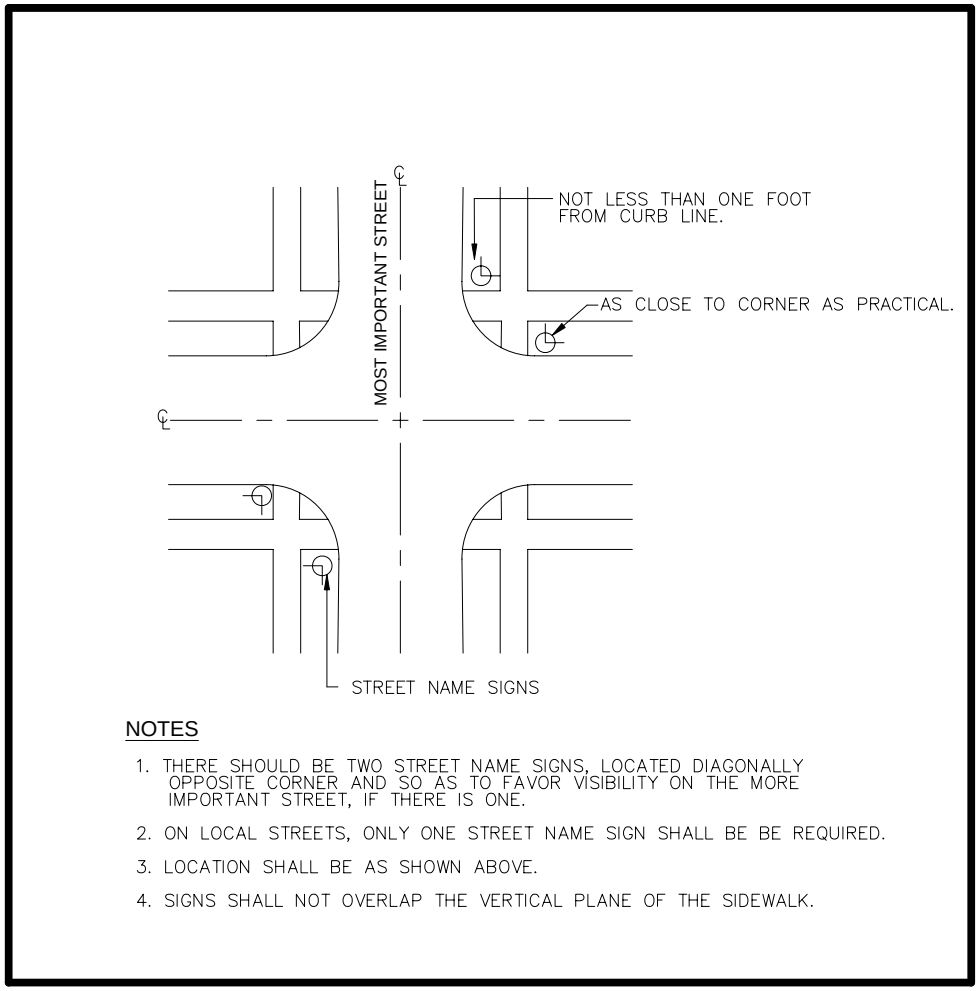


Figure 5-44 Development Name Signs – I

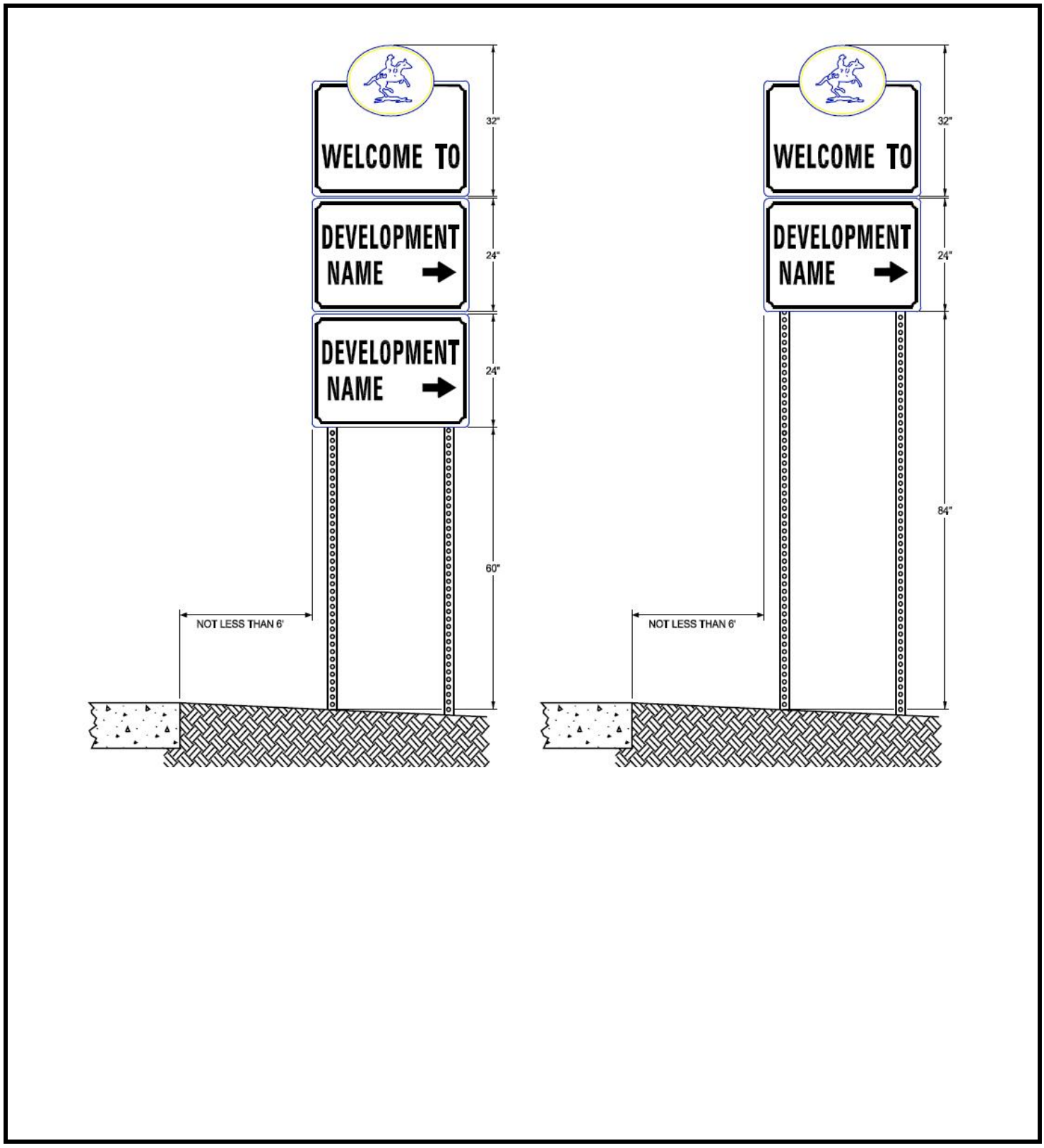


Figure 5-45 Development Name Signs – II

SPECIFICATIONS

SIGN BACKGROUND WILL BE COVERED WITH HIGH INTENSITY TYPE LLL-REFLECTIVE MATERIAL BLUE (3M SCOTCHLITE 3875 OR EQUIVALENT).

CAESAR RODNEY BACKGROUND WILL BE HIGH INTENSITY TYPE LLL YELLOW (3M SCOTCHLITE 3871) AND RIDER AND BORDER WILL BE BLUE (3M SCOTCHLITE 3875 OR EQUIVALENT).

SIGN LEGEND AND BORDER WILL BE HIGH INTENSITY TYPE LLL SILVER (3M SCOTCHLITE 3870 OR EQUIVALENT).

LETTERING IS 5" HIGHWAY GOTHIC "C"

SIGNS BLANKS WILL BE MANUFACTURED FROM .080" COATED ALUMINUM.

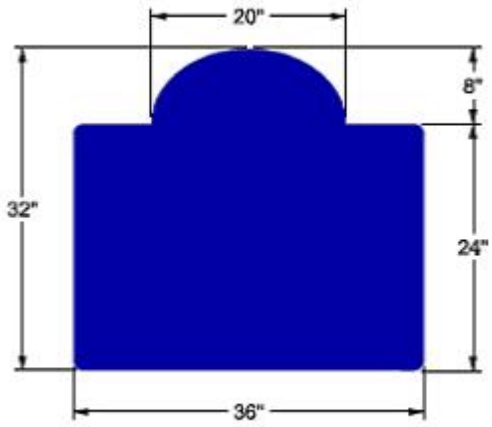


Figure 5-46 Striping Plan – Right Turn Lane and Bypass Lane
(Not to Scale)